TOP SHOP TIPS
FROM READERS

ROUTER MAKEOVER
5 EASY STEPS TO GET YOUR #1 TOOL IN SHAPE

ShopNotes®

Vol. 15 Issue 88

THE ULTIMATE SHOP-BUILT PANEL SAW

A Quick & Easy Way to Crosscut & Rip Plywood pg. 16

TABLE SAW TECHNIQUE

The Secret to Adding Graceful Curves to Your Next Project

EXCLUSIVE ROUTER TABLE JOINERY

No-Fuss, Easy & Accurate

PLUS! HANDY MUST-HAVE TOTES

pg. 28

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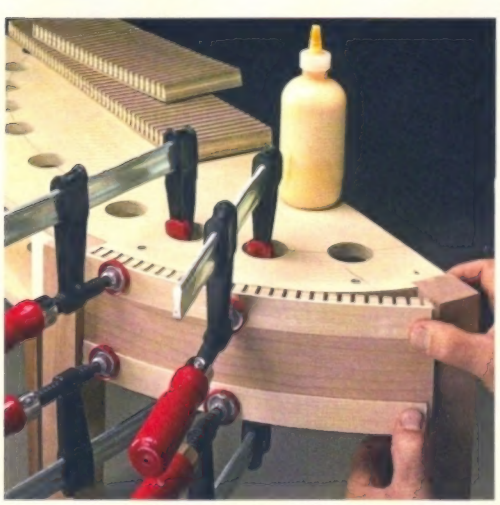

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Cutoffs

Let's face it, maneuvering and breaking down full sheets of plywood on the table saw can be a real pain. The sheets are heavy, awkward, and difficult to control. Production shops solve the problem by using a panel saw to cut sheets down to size.

Commercial panel saws use a metal frame to hold a plywood sheet upright. Then a circular saw mounted to a carriage in the center of the frame is used to crosscut or rip the sheet. It's a slick set-up, but there are a couple of problems.

First, panel saws are expensive. A new one can set you back several thousand dollars. Second, you need a lot of wall space to accommodate one. (To rip a full sheet, you need a minimum of eight feet in front of the carriage and another eight feet behind it.)

In this issue, our feature project solves both of these problems. For starters, instead of a fixed, center-mounted carriage, our shop-built panel saw features a carriage that moves side-to-side. This way, all you have to do to make a rip cut is slide the carriage over the sheet. And since the plywood doesn't have to be pushed through the saw, you don't need as much wall space. In fact, all you need is ten feet — about half as much as a traditional panel saw.

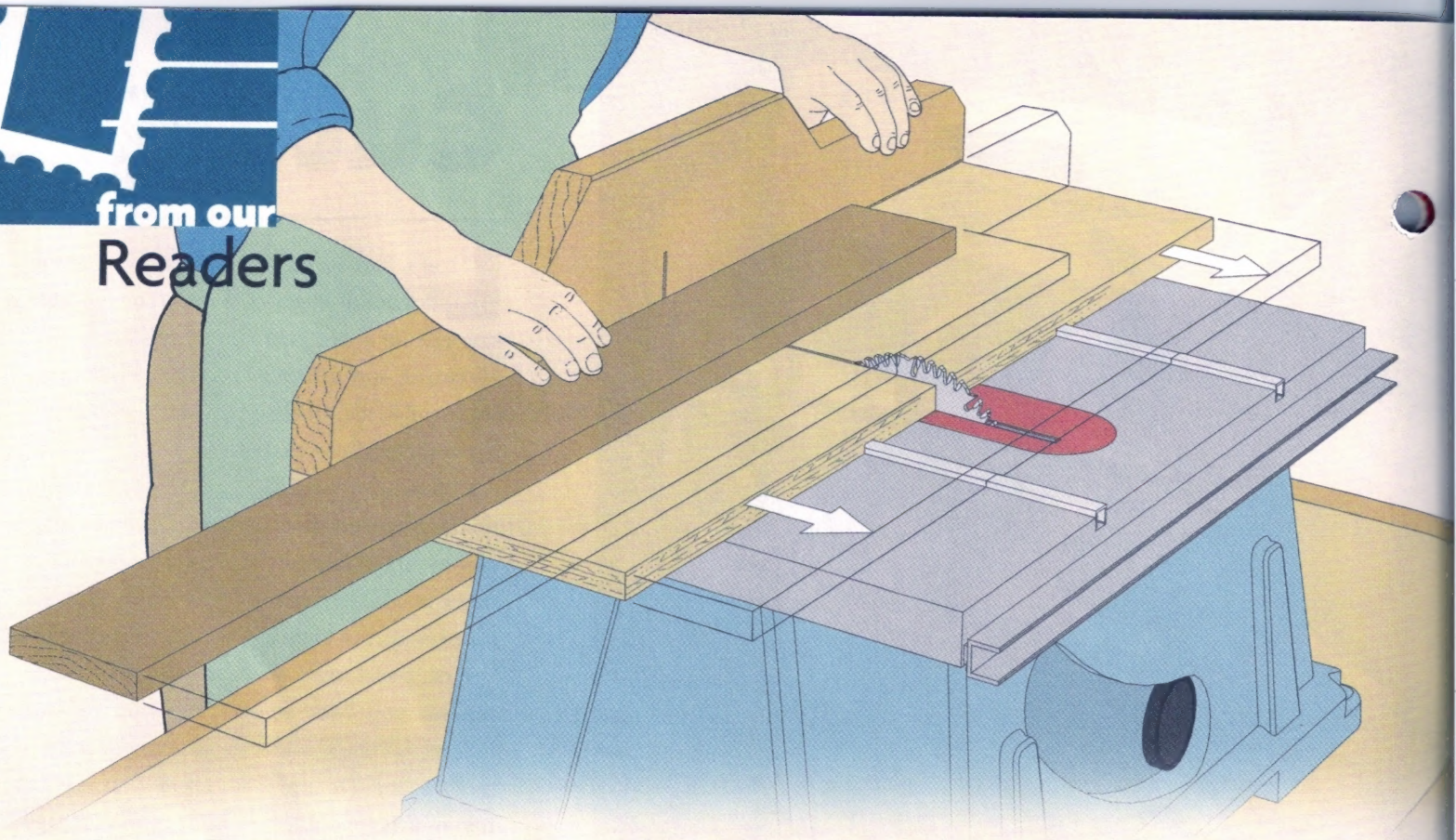
Not only does this new design save space in your shop, but you can save money too. If you already have a circular saw, you can build the panel saw for about $350 in materials. A real bargain compared to buying one.

Terry

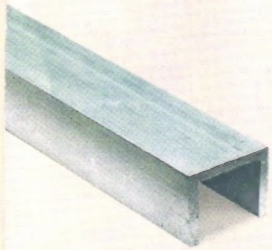
ShopNotes GO ONLINE EXTRAS

This symbol lets you know there's more information available online at **www.ShopNotes.com**

from our Readers



Tips for Your Shop



▲ *Drywall Channel.* *Aluminum channel can be cut to size and press-fit into the miter slot of your benchtop table saw.*

Benchtop Table Saw Sled

The table of the portable saw I use in my shop is often not large enough to cut anything other than small pieces safely and accurately. So I decided to add a crosscut sled.

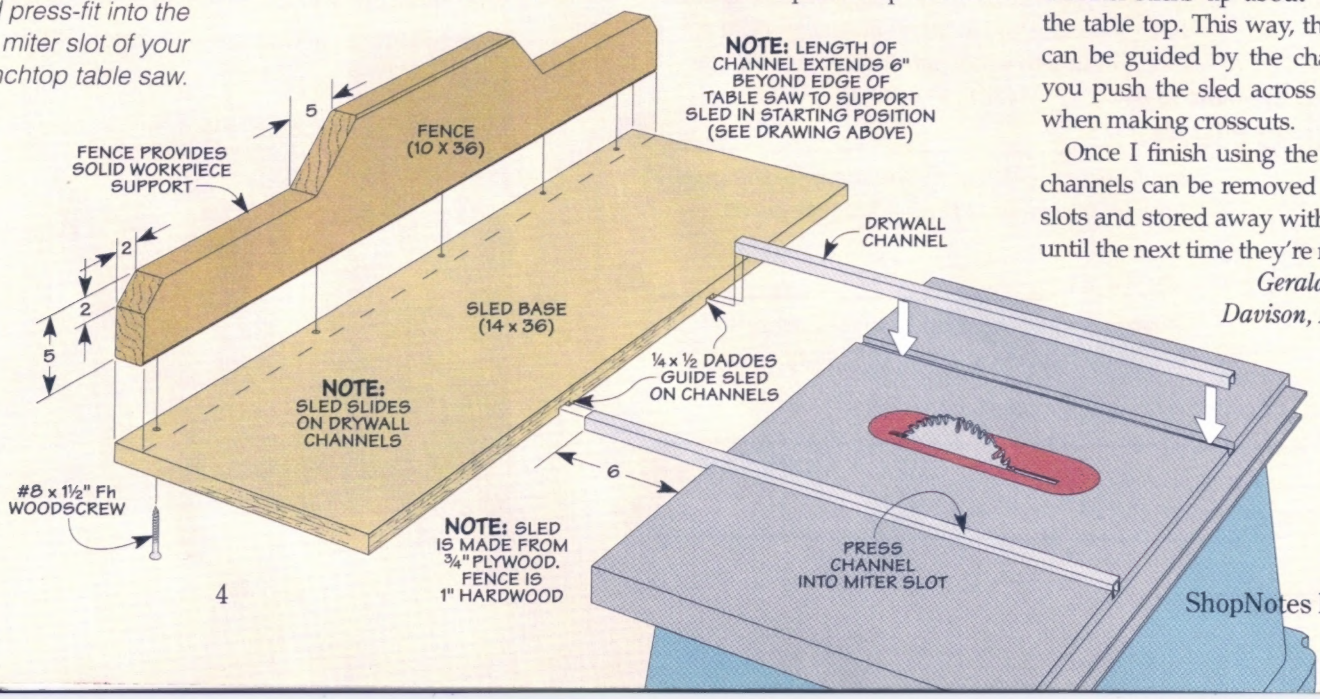
I cut a couple of dadoes in the underside of the sled to ride over rails that will be fit into the miter slots later. These dadoes correspond to the position of the miter slots on the saw, as shown below.

The miter channels on my saw were too small to accept most manufactured runners and miter bars. So I used a piece of ½" drywall channel that I picked up at a local home improvement center to make a set of rails for the sled to slide on.

The rails are easy to make. First, cut the drywall channel to a length that's a little longer than the miter slot. Then press-fit the channel into the miter slot. You'll find the channel sticks up about ¼" above the table top. This way, the dadoes can be guided by the channels as you push the sled across the table when making crosscuts.

Once I finish using the sled, the channels can be removed from the slots and stored away with the sled until the next time they're needed.

Gerald Layman
Davison, Michigan



Fold-up Router Table

My workshop shares space with the *family car. So it's important that all of* my power tools be portable and take up as little space as possible. After building the upgraded router table top from issue No. 85, I attached the table top to a pair of *2x4's with screws. Then, after removing* the top of an adjustable clamping table, I mounted the router table to the clamping table stand, as shown in the photo below. The table is firmly supported by the clamping table base.

The nice thing about the table is it can be raised and lowered to match the task at hand. Best of all, I can remove the router and quickly fold the table up to store it against the wall whenever it's not in use.

Kurt Soukup
Spring, Texas

Submit Your Tips

If you have an original shop tip, we would like to hear from you and consider publishing your tip in one or more of our publications. Just write down your tip and mail it to: *ShopNotes,* Tips for Your Shop, 2200 Grand Avenue, Des Moines, Iowa 50312. Please include your name, address, and daytime phone number (in case we have any questions). If you would like, you can FAX it to us at 515-282-6741 or simply send us an email message at: shopnotes@shopnotes.com. We will pay up to $200 if we publish your tip.

The Winner!

Congratulations to Clark Robbins of West Lake, Michigan. His tip on making a micro-adjust for the router fence was selected as winner of the *Porter-Cable* router just like the one shown at the right. The micro-adjust allows accurate adjustments to be made to the router fence.

To find out how you could win a *Porter-Cable* router check out the information above. Your tip just might be a winner.

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Micro-Adjust Your Router Table Fence

The router table in my shop gets lots of use. But it's always difficut to make fine adjustments to the fence. So I built the micro-adjuster you see in the photo above using a few parts I had around the shop.

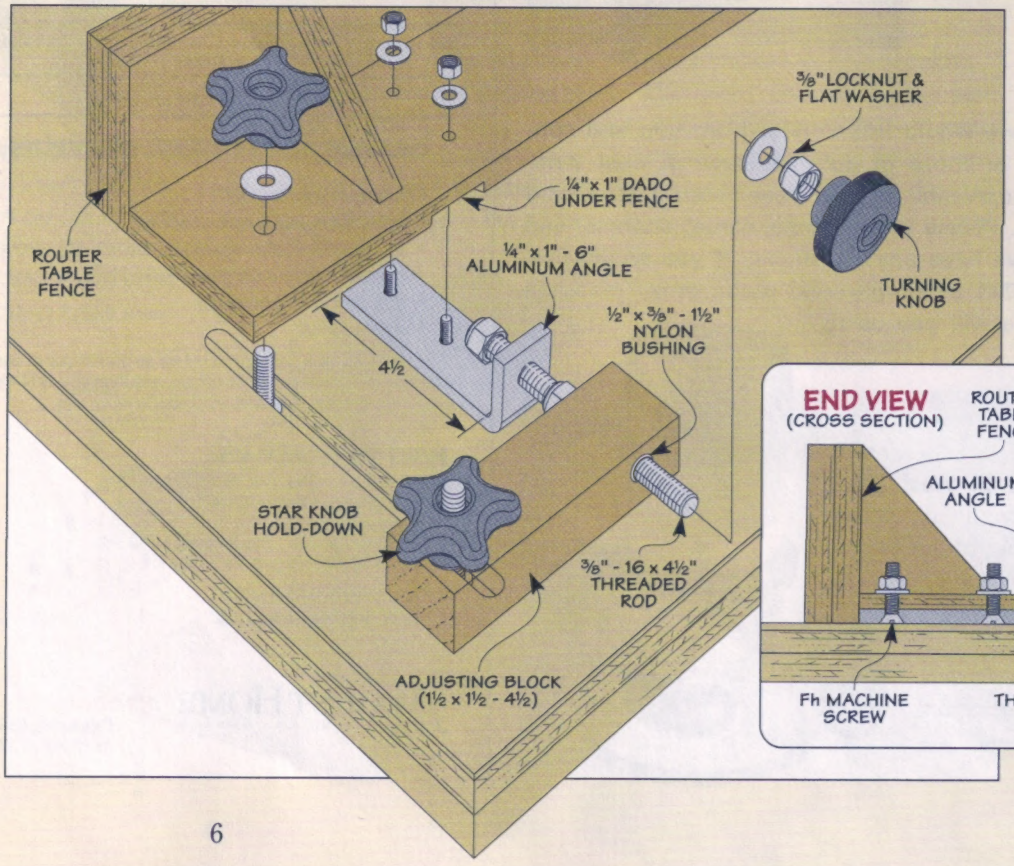
The adjuster is easy to build. Start by drilling and tapping a strip of ¼" aluminum to accept a piece of threaded rod. And then bend the aluminum strip into an "L" shape.

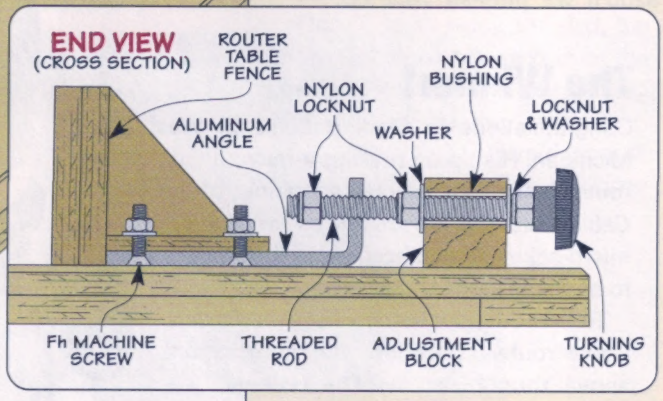
Next, drill two holes in a hardwood adjusting block. One horizontal hole for the threaded rod and a vertical one for the hold-down. Then you can cut a dado at the bottom of the fence to hold the piece of L-shaped aluminum in place.

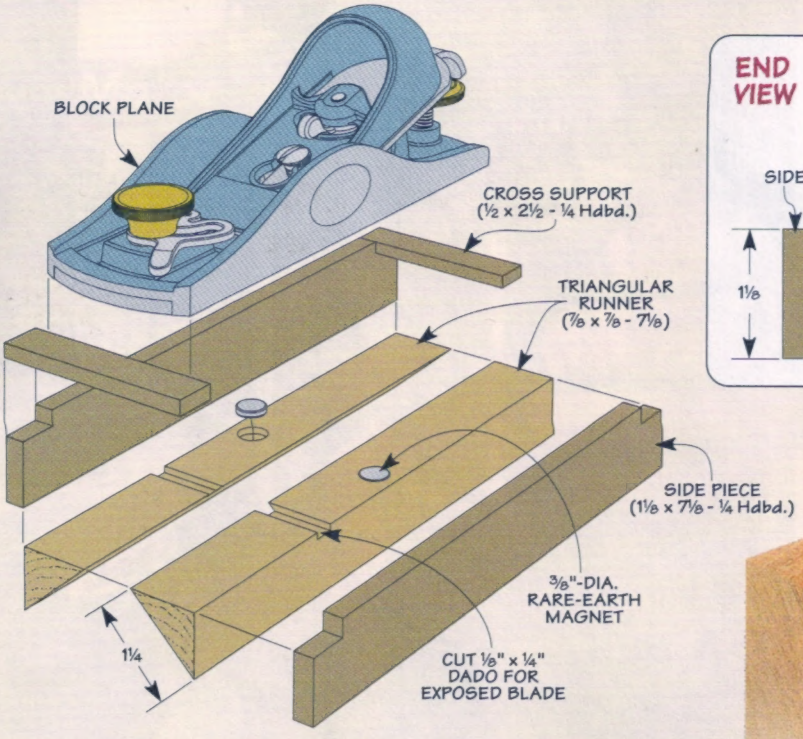
Assembly. Put the pieces together by slipping the threaded rod through the adjusting block and add washers and locknuts, like you see in the drawing and detail below. This allows the aluminum strip attached to the fence to be moved forward and backward one thread at a time when you make fine fence adjustments.

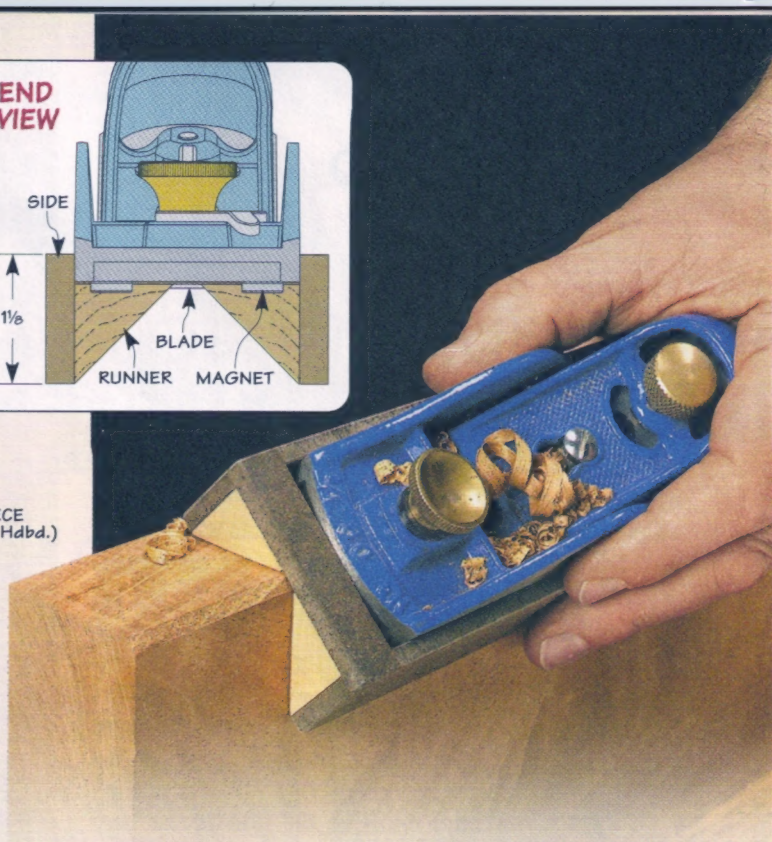
Fence Adjustment. To use the micro-adjuster you'll first need to lock down the opposite end of the fence. Then set the micro-adjuster by tightening the knob on top of the adjusting block. Use the turning knob to adjust the fence to the desired position. Once the fence is located where you want it, lock down the other end of the fence. *Then all that's left is to turn on your router and you're ready to go.*

Clark Robbins
White Lake, Michigan









Chamfer Plane

A block plane makes quick work of chamfering the edge of a workpiece. To ensure a constant width and angle of the chamfer, I built the base shown in the photo above. It slips over the plane to make ¼" chamfers and doesn't require any setup.

The base is simply two triangular-shaped runners glued to a pair of side pieces. Then cross supports are glued into notches in the front and back to hold the sides together.

Two rare-earth magnets glued into recesses in the runners hold the plane securely in place. A shallow dado is cut in the top of the runners at the mouth of the plane for the exposed iron.

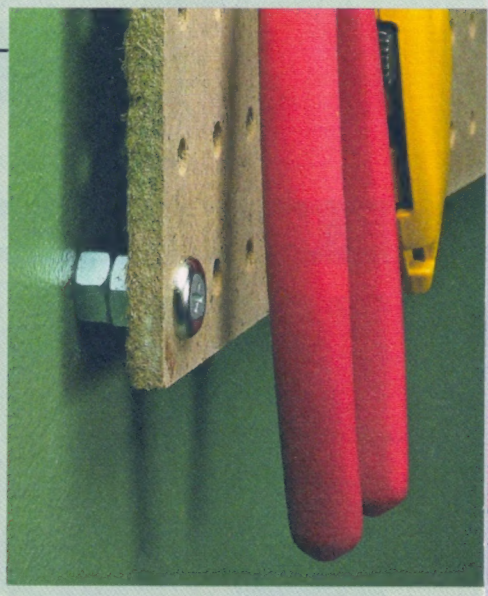
The base is easy to use. With your block plane in the base, position the V-shaped groove of the runners over the edge of the workpiece. Then plane the workpiece until both sides sit flush. It worked so well I made a second one for ⅛" chamfers.

Frank Penicka
Mount Pearl, Nfld., Canada

Quick Tips

▲ **P.A. Jones** of Gig Harbor, WA, stores her veneered edgebanding in empty cookie tins. Since the tins seal tightly when closed, they keep the edge banding organized, safe from damage, and protected from moisture until they're ready to be used.

▲ Whenever a wing nut needs adjustment, **Len Urban** of Rancho Mirage, CA, uses a wrench made by routing a stopped groove in a piece of hardwood for leverage.



▲ **Michael Bethel** of Louisville, KY, stacks ⅜" hex nuts he has around the shop to provide standoff space whenever he needs to mount pegboard to the wall.

A quick 5-step Router Tune-up

On some days, it seems like I turn my router on first thing in the morning and it only goes off with the lights at the end of the day. While this might be a stretch, I'm guessing you can relate to the value of a well-tuned router.

The emphasis here is on *well-tuned*, because when the router you depend on isn't working right, things can get frustrating real fast. That's why I make it a point to periodically give my router a quick "once over." This simple five-step tune-up only takes a few minutes and easily pays for itself in less wasted time and aggravation. The workhorse router in my shop is the *Porter-Cable 690* shown in the photos, but the same basic steps apply to almost any router.

1. Height Adjustment

First, I turn my attention to the inside of the router base and the motor housing that slides into it. The problem is that after countless bit changes, height adjustments, and the cuts that follow, these two parts get roughed up and covered with grime. Once this happens, you can forget about making the quick, accurate height adjustments that you rely on.

But solving this problem is pretty simple. First, take some fine sandpaper or an abrasive pad and use it to remove the accumulated grime, scratches, and burrs from the motor housing (photo above). Next, do the same to the inside of the base. A small wire brush will get into the grooves in the base that can get caked with dust. And after wiping down the motor and base, a light coat of spray lubricant completes the job.

2. Lock Mechanism

▲ **Out With the Old.** *The bolt is bent, the knob chewed up and the threads are wearing out.*

▲ **In With the New.** *An inexpensive solution is to upgrade to an easy-to-grip, lever-type lock.*

The next step is to inspect the mechanism used to lock the motor in place after you adjust the bit height. For most routers, this means tightening a knob and bolt to clamp the base snugly around the motor. Ideally, firm finger pressure should be all that's needed to tighten or loosen the knob — no pliers. And when tightened, the motor shouldn't budge.

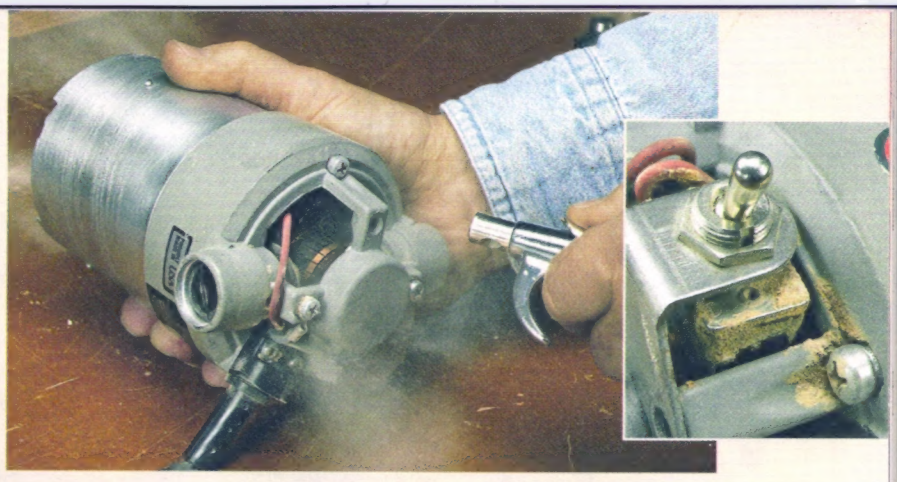
Cleaning and lubrication with some light grease is the first step. This will often free up a sticky mechanism. But with heavy use, this is one part of a router that just plain wears out. So if on inspection, your lock is starting to look like the one in the photo at left, don't take a chance. You can replace or upgrade the lock and not have to worry about surprise height changes.

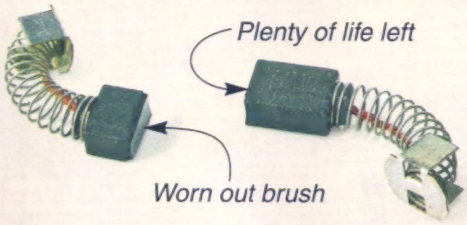
3. Motor

Although a router motor is designed to stand up to hard use and dirty conditions, there are a couple of routine things you can do to keep it and all the other electrical parts in top shape.

Dust is the number one enemy here. It's constantly being sucked through the motor and settling in every nook and cranny. So the goal is to prevent excessive wear by keeping the inside of the motor as clean as possible. The photo at right shows how easy this is. After removing the motor cover, a sharp blast of compressed air will dislodge most of the dust. And as you can see in the inset photo, the switch and other electrical connections need attention as well.

Brushes. While cleaning the motor, I like to inspect the brushes. Badly worn or chipped brushes make the motor work harder. The near brush in the photo at left is pretty worn and ready for replacement.





▲ ***Blow Out the Dust.*** *It's unavoidable — the inside of a router traps dust. But all it takes to clean out the motor and the important electrical connections is a blast of compressed air.*

4. Base Plate

The phenolic base plate is where the router meets the wood. So naturally, it gets a lot of wear and tear. And a rough, dinged-up base plate can make routing harder and possibly leave "tracks" on the workpiece.

The simple cure for a worn base plate is shown in the photos at right. First, I make sure the base plate screws are tightened securely. Then I use some fine sandpaper on a sanding block to remove any scratches or burrs. A quick buffing with a fine abrasive pad follows. The final step is simply to minimize any friction, as shown in the far right photo.

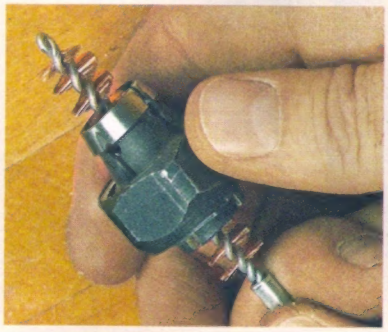
▲ ***Keep It Smooth.*** *Lightly sanding the base plate with fine-grit sandpaper will keep it smooth and level.*

▲ ***Make It Slick.*** *A light coat of surface lubricant will make the base plate slide effortlessly.*

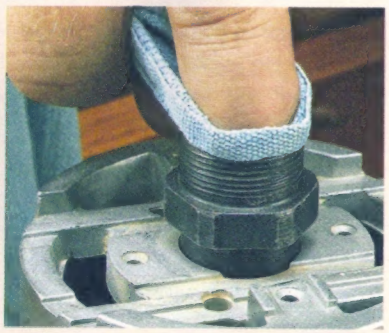
5. Collet

The final stop is the business end of the router — the collet that holds the bit. The goal here is to make certain the collet gets a guaranteed, rock-solid grip on the bit while also allowing hassle-free bit changes. The photos below show my short checklist.

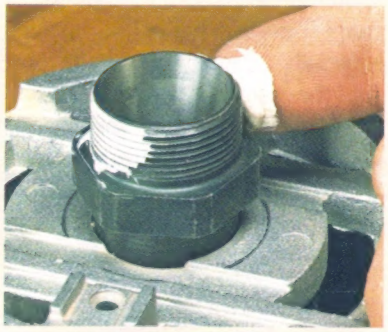
First, I work on the shank hole in the collet. It should be smooth and clean. Next, you want to make sure the collet seats properly by cleaning the debris out the arbor socket. Finally, I lubricate the threads so that the collet nut can be tightened and loosened easily.



▲ ***A Clean Shank Hole.*** *A brass wire brush is the perfect tool for gently cleaning the shank hole.*



▲ ***A Snug Fit.*** *The accumulated dust and debris in the arbor socket should be wiped or blown out.*



▲ ***Lubrication.*** *A coat of white grease on the arbor threads ensures hassle-free bit changes.*

problem-solving Euro-style Hinges

When you come up against a tricky door installation, chances are there's a hinge that will do the job.

Clip-On Hinges. *An easy-to-use spring-loaded clip connects the mounting plate and the hinge.*

European-style or concealed hinges were originally designed to solve a specific problem. Builders needed a hinge that would work on a cabinet without a face frame, be easy to mount and adjust, and finally, not be visible. A tall order. But what the designers came up with hit the nail right on the head.

These two-part hinges were so handy that woodworkers wanted to adapt them to other applications — especially problem installations. And the designers answered the call. Now, the challenge is keeping up with all the new types being offered. Here are a few special hinges that may come in handy in your shop. You'll find sources on page 51.

FACE FRAME HINGES

The original Euro-style hinges were not meant for use on cabinets with a face frame. To work correctly, the hinge mounting plate had to be fastened directly to the side of the cabinet. To use them on a face frame (and many woodworkers did), you had to shim out the sides of the cabinet flush with the edge of the face frame.

This extra work is no longer necessary. Today, as shown in the main photo above, you can find several types of Euro-style hinges that will easily handle all kinds of face frame applications.

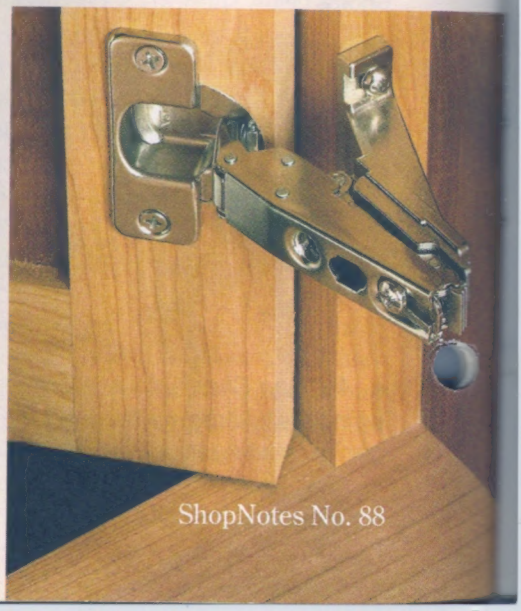
CLIP-ON HINGES

When I first used Euro-style hinges, I found one minor inconvenience. The hinge and the mounting plate were held together with one of the screws that was responsible for making adjustments to the position of the door. So every time I removed and reinstalled the door, the position had to be readjusted.

The clip-on feature, shown in the inset photo at left, changed all that. Here, the hinge and the mounting plate simply snap together and the door stays in adjustment. This handy option is available on most types and brands of Euro-style hinges.

INSET DOOR HINGE

Inset doors that sit flush with the outside of a face frame are a favorite of mine. Now there's a Euro-style hinge specifically made to handle



► ***Inset Doors.*** *You get the classic look of an inset door with all the features of a Euro-style hinge.*

Wraparound Hinge. *When you want an open door to be unseen and out of the way, this hinge will do the job.*

Zero-Protrusion Hinge. *This clever hinge moves the door in two directions at once. So you get complete access.*

this door type. As you can see in the lower photo on page 10, this hinge has a unique mounting plate that is screwed directly to the back side of the face frame. This makes installing an inset door quick and easy — with no modifications to the cabinet.

WRAPAROUND HINGE

Nowadays, entertainment and media centers are really popular projects. They give the look of a beautiful piece of furniture while hiding all your electronic gear behind closed doors. The problem comes when you open the doors for access. With a standard hinge, they're left standing out from the cabinet like a pair of wings.

The left photos above show the answer. This 270° degree wraparound hinge can be easily installed on cabinets without a face frame. The neat trick is that it allows the door to fold out of the way, snug to the side of the case.

MINI CUP HINGE

To mount a Euro-style hinge, you have to bore a large "cup" hole in the back of the door along one edge. The standard diameter for this hole is 35 mm or about 1⅜".

In most cases, this isn't a problem. But in the narrow, rabbeted door stile, shown in the lower left photo, you can see this size hole won't work. In this situation, a switch to a mini cup hinge is an easy fix. This type only requires a 26 mm cup hole (about 1") and is a much better fit.

ZERO-PROTRUSION HINGE

Adding pullout shelves or drawers to the inside of a cabinet can be a great convenience. But here's the catch. Even when opened wide, the doors can end up partially blocking the opening. Banged up doors and pullouts are usually the result.

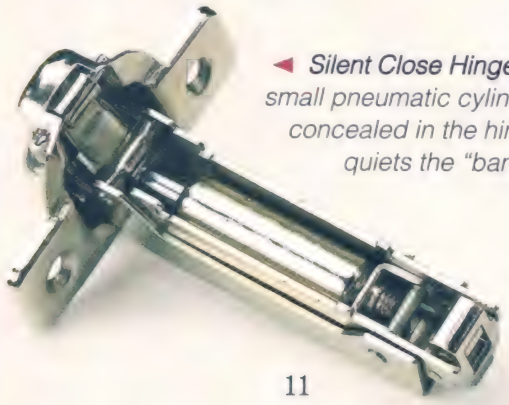
Using zero-protrusion hinges, like the one shown above, solves the problem. As the hinge swings the door open, it also moves it back out of the opening. At just past 90°, the door clears the opening and the pullout is free to slide.

SILENT CLOSE HINGE

Many, newer Euro-style hinges are self-closing. When the door reaches a certain angle, a strong spring in the hinge snaps it closed. This is a nice convenience but can be annoying. A loud bang and the chance of pinched fingers are the downside.

Well, how about a hinge that closes so softly you won't hear it *or* feel it. The *Evolve™ Silent Close* hinge, shown below, contains a small pneumatic cylinder that counteracts the spring in the hinge to close the door whisper quiet.

A Smaller Hole. *The 35 mm hole on the right is too large. The mini cup is a much better fit for a narrow stile.*



◄ **Silent Close Hinge.** *A small pneumatic cylinder concealed in the hinge quiets the "bang."*

the do-it-all Pattern-maker's Vise

Add versatility to your workbench with this top-of-the-line vise.

At the turn of the 20th century, *Emmert Manufacturing* produced a bench vise to help patternmakers make wood parts for castings used in manufacturing.

Unlike typical vises, the *Emmert* vise could twist and turn in several directions and angles. This allowed patternmakers to adjust a workpiece to a comfortable position without having to loosen the vise, adjust the workpiece, and tighten it down again. Simply flip a lever here or a knob there, and position the vise (and the workpiece) right where it needs to be.

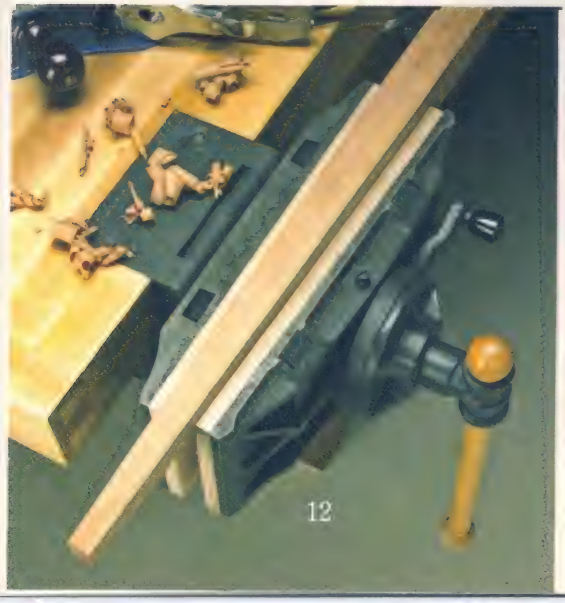
While the company no longer exists, the *Emmert* is still a highly sought-after vise, commanding prices up to $800. Fortunately, other companies now make similar vises (see Sources on page 51.)

Versatility. In the "normal" position, this vise works just like any bench vise. Spinning the handle opens and closes the front jaw to hold a workpiece. Unfortunately, the jaws of a standard bench vise can't get a good grip on a tapered workpiece, such as a table leg.

However, by adjusting the collar on the face of this vise, you can swivel the front jaw up to 5° to grip the workpiece (far left photo). For workpieces with steeper tapers, you can add an accessory to hold the workpiece (see box on next page).

Tilting. But what really sets this vise apart from a typical woodworking vise is the tilt feature. You can see what I'm talking about in the photo on the left.

▼ *Holds Tapers. The front jaw swivels up to 5° to grip a tapered workpiece.*



◄ *Tilts Horizontal. This vise can tilt a full 90°, and its jaws can open as much as a foot wide.*

The vise can be tilted upward a full 90° so it's parallel to your benchtop. To do this, simply reach underneath the workbench to the back of the vise and loosen the cam lever that locks the tilting bar. And, if you need to, you can lock the vise, along with the workpiece, anywhere along the way.

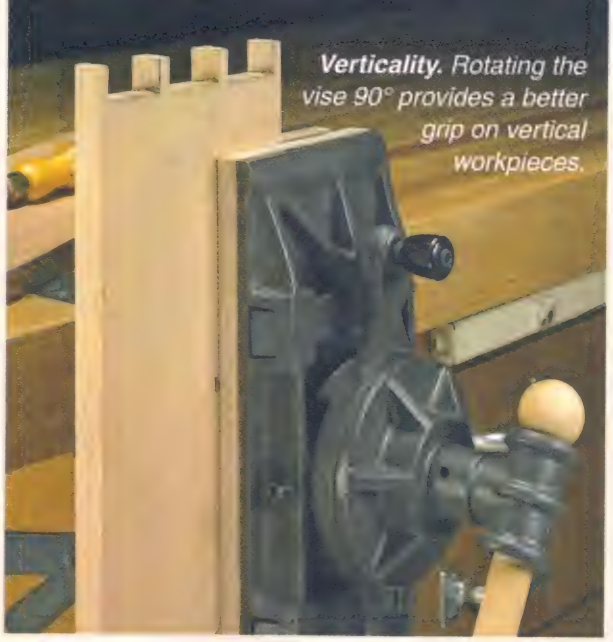
Rotation. Besides tilting the vise, you can rotate the vise a full 360° at the same time. For example, you can rotate it 90° to let the jaw's long edges grip a vertical workpiece (top left photo) to handcut dovetails for a drawer. Or, you can tilt and rotate the vise to position a complex workpiece like a cabriole leg for easy access (main photo on opposite page).

Little Jaws. The extra-wide jaws can open as much as a foot and are great for large workpieces. For smaller workpieces, you can rotate the vise 180° to use a pair of smaller jaws. These 2" jaws have the advantage of holding workpieces above the benchtop (see top right photo).

Heavy Metal. But all this versatility comes at a cost. First, these vises are made of cast iron and steel and can weigh 50-55 lbs. So, you'll need a heavy-duty workbench to mount this vise.

Second, the vise you see here sells for $200. Other vise makers add features and refinements that can push the price to as high as $650. So, shop around and get what's best for you.

When all is said and done, though, a patternmaker's vise is the top of the line when it comes to woodworking vises.



Verticality. *Rotating the vise 90° provides a better grip on vertical workpieces.*

▲ ***Small Jaws.*** *Spin the vise around to use a pair of 2" jaws that hold small workpieces above the benchtop.*

Options: Extra Holding

If all the tilting and rotating aren't enough, there are a couple of accessories that make a patternmaker's vise even more versatile.

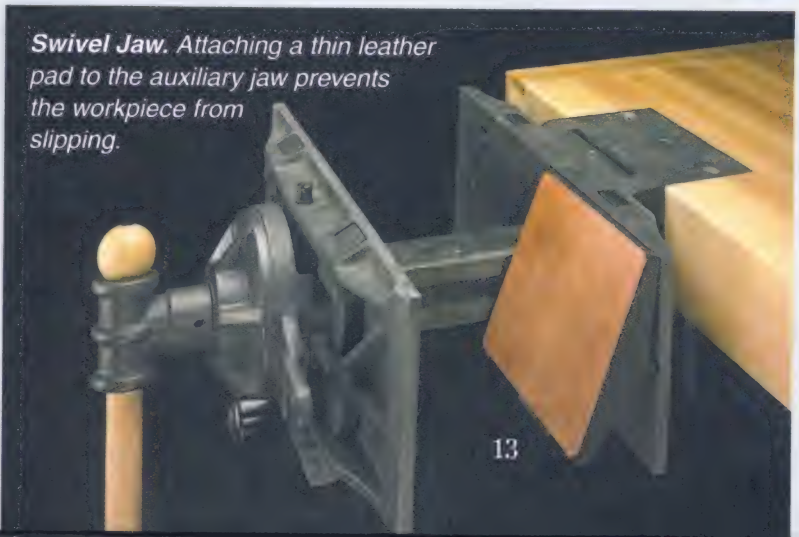
Vise Dogs. The top photo at right shows the two pairs of spring-loaded dogs. Two dogs are located on the front jaw and the other two are in the rear. These dogs allow you to clamp odd-shaped workpieces. Or, you can just use the dogs on the front jaw with your bench dogs to help hold wider workpieces.

To use the vise dogs, just push up on the round extensions that stick out from underneath the jaws. Springs hold the dogs in place, and all you have to do then is tighten the vise to secure the workpiece.

Swivel Jaw. The bottom photo shows an auxiliary swivel jaw that mounts to the right side of the rear jaw. This auxiliary swivel jaw can tilt as much as 30° in either direction (top to bottom) to hold workpieces that have steep tapers.

The auxiliary jaw is designed to be attached and removed quickly and easily. It has a tongue that inserts into a square hole in the rear main jaw. A ridge along the back of the auxiliary jaw fits into a groove in the rear jaw. This gives the auxiliary jaw its ability to easily swivel up and down.

Extension Dogs. *Spring-loaded dogs hold odd-shaped workpieces with ease.*



Swivel Jaw. *Attaching a thin leather pad to the auxiliary jaw prevents the workpiece from slipping.*

Shop Short Cuts

Saw Guide Cutout

There were a few things about building the panel saw on page 16 that had me scratching my head.

The biggest challenge was finding a way to make the cutout in the sliding saw carriage. You could make this cut with a jig saw. But I wanted a straight, clean edge.

Plunge Cut. The answer was to use the table saw. In a nutshell, this involved raising the blade up through the workpiece. But making a blind cut like this calls for careful setup. I started by drawing the cutout on the workpiece, extending the end lines to the edge of the panel (photo at right).

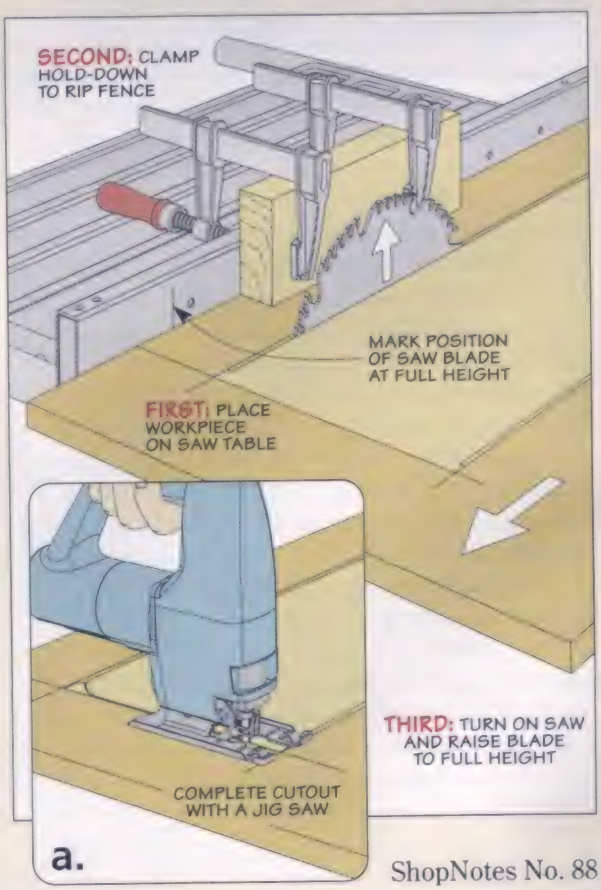
Next, with the saw turned off, I raised the blade to its highest position and marked the location of the back edge of the blade on the rip fence, as you can see in the photo above and the drawing at right below. Then I positioned the rip fence to make the first cut.

Making the Cut. Before turning on the saw, I lowered the blade below the table. Then, I aligned the layout line of the workpiece with the mark on the rip fence.

Finally, I clamped a hold-down to the rip fence to keep the workpiece flat on the table.

To start the cut, turn on the saw and slowly raise the blade up to its highest position. Then you can make the cut. When you reach the end of the cut, turn off the saw.

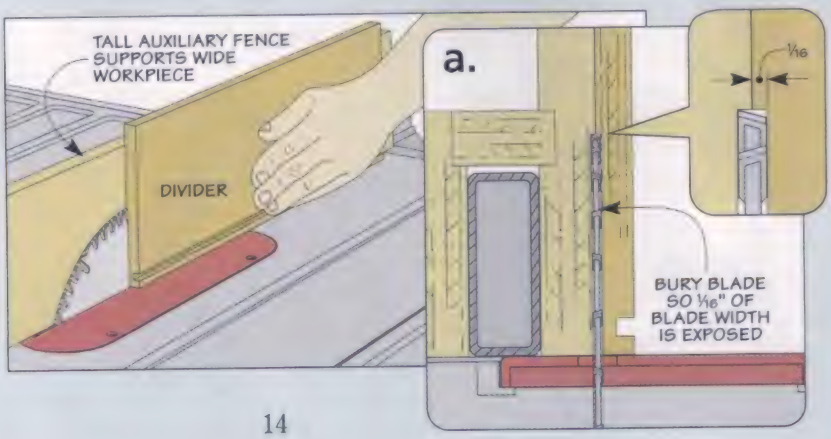
End Cuts. After cutting the other side, you can cut the ends. These aren't critical, so I used a jig saw.



Cutting a shallow Rabbet

One of the great features of the totes on page 28 is how they stack on top of each other. To keep the stacked totes from binding, I made a relief cut along the bottom inside edge of the dividers.

This detail is really just a wide, shallow rabbet. So you can cut it on the table saw with the parts upright. The trick is supporting such a tall workpiece. In the drawings below, you can see how I buried the blade in a tall auxiliary fence. To recess the blade, I set the rip fence in position and slowly raised the blade to the right height.

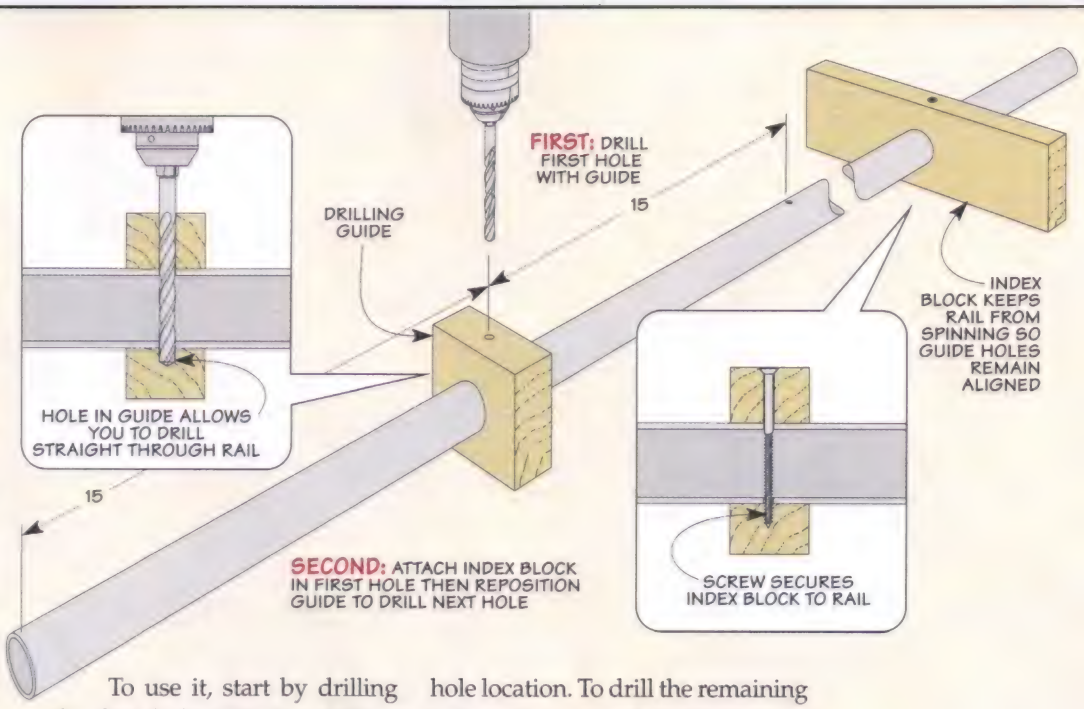


Drilling Carriage Rail

The key to cutting accurately with the panel saw is to make sure the conduit the saw carriage rides on is mounted flat and straight. To do this, you need to drill the holes straight through the conduit. At the same time, you also have to drill the holes in line with each other.

Drill Guide. To take care of the first problem, I made a drilling guide (drawing at right). The guide slips over the conduit and has a cross hole that I drilled at the drill press to guide the bit. Now, it's just a matter of sliding the guide to the right location and drilling the holes with a hand drill.

Index Block. To keep all the holes in the same line, I made a long index block like you see in the drawing above. It's basically a longer version of the drilling guide.



To use it, start by drilling the first hole with the drilling guide. Then position the index block over the conduit and drive a screw through the hole in the conduit to hold it firmly in place, as shown in the right detail. Now, move the guide over to the next hole location. To drill the remaining holes, all you need to do is move the drilling guide. The index block keeps the rail in the same position for perfect hole alignment.

Panel Saw: Creating a Pocket

One other challenge I came across while building the panel saw was making the saw base. To hold the circular saw securely on the base, it sits in a shallow pocket made for both the rip and crosscut positions. The saw is held in place by a set of quick-release toggle clamps.

Making the base blank is pretty straightforward. It's just a small piece of plywood. The trick is making the pockets for a hand-in-glove fit. But with a router and a short pattern bit, you'll find that the solution is no trick at all.

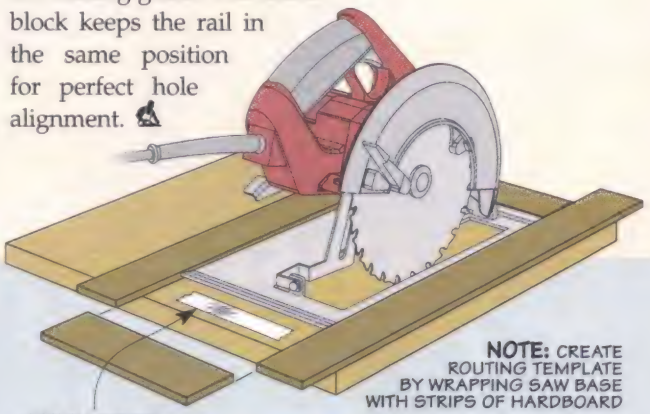
Create a Template. To begin with, place your saw in the crosscut position on the base. Just be sure the blade is parallel to the edge. Then you can create a template by cutting strips of ¼" hardboard to wrap around the saw base. Carpet tape will hold them in place, as shown in the top drawing at right.

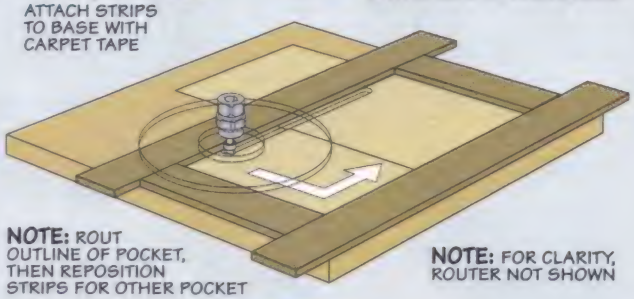
Rout the Outline. Now, with the pattern bit, rout the outline of the saw base (second drawing from the top). Next, peel off the strips and place the saw in the rip position. Then repeat the routing process.

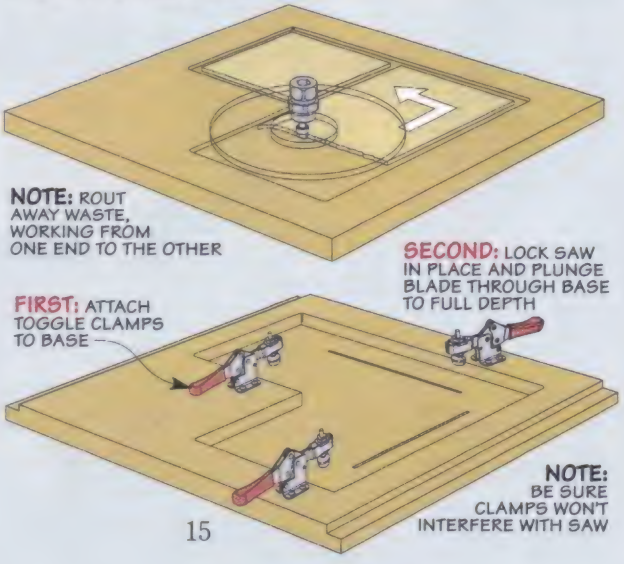
Remove the Waste. With the outline of the pockets established, you can clean up the remaining waste. For this, you'll need to remove all the strips and reset the bit depth to match the outline grooves you just made. Then, starting at one end of the pocket, work the router back and forth across the waste until you have a clean, flat recess.

A Few Tweaks. Before attaching the toggle clamps, there are a few other details you may need to take care of. First, you might need to square up the corners of the pockets with a chisel.

Then, depending on the saw, you may need to rout additional relief pockets for the handle or motor to allow your saw to sit flat in the pocket. You can trace the outlines and rout the recesses freehand.







dream shop
project

sliding-carriage Panel Saw

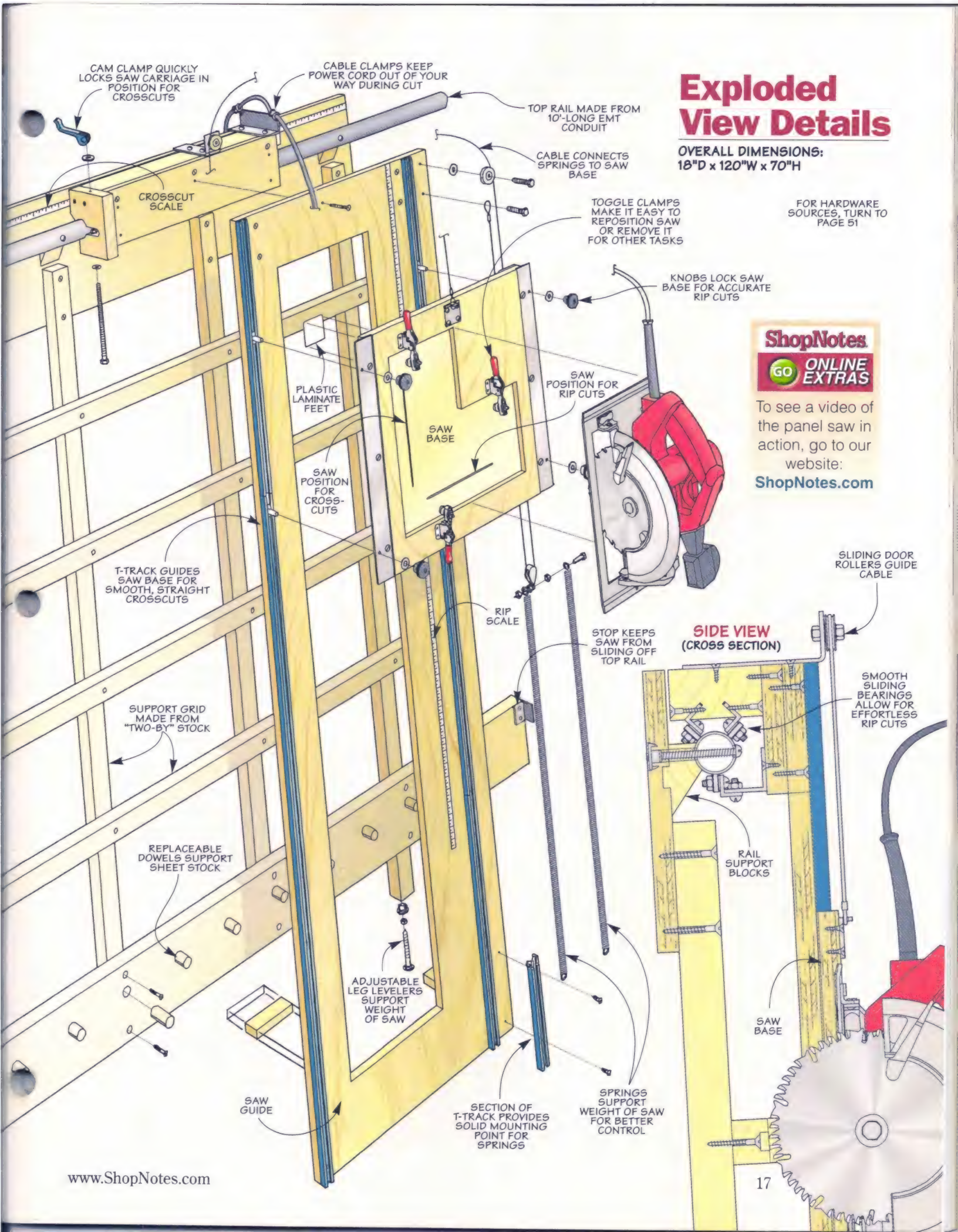
It's the hassle-free way to cut plywood. And it has features that will save you time and money.

Rip Cuts. *When ripping sheet goods, the saw slides along the top rail for smooth, easy cuts.*

An easy way to break down sheets of plywood is on a panel saw. The trouble is, these saws can cost a thousand dollars or more. But besides cost, most panel saws take up a lot of wall space. That's because the saw carriage is fixed, so you need ample room to load and unload the panel. And for ripping, that means you'll need a full 8' on both the "infeed" and "outfeed" side of the saw.

But the panel saw you see here solves both of these problems. First of all, you'll save a lot of money by building the saw yourself. (Ours cost less than $350, without the circular saw.)

And second, once the sheet of plywood is in place, it never moves. Instead, a sliding carriage guides the circular saw so you can make both rip and crosscuts accurately.



Exploded View Details

OVERALL DIMENSIONS:
18"D x 120"W x 70"H

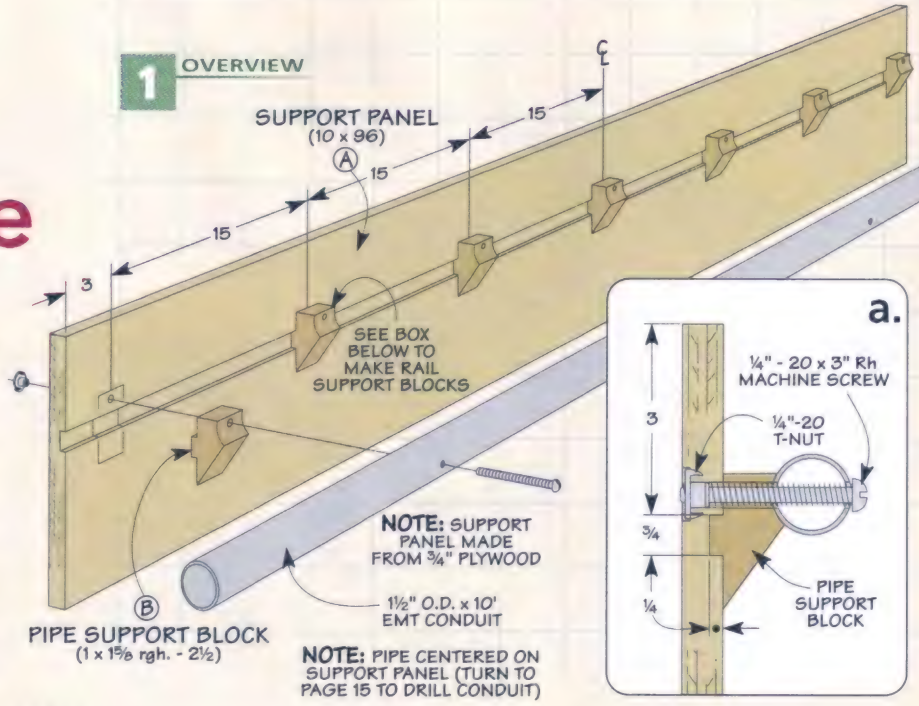
FOR HARDWARE SOURCES, TURN TO PAGE 51

ShopNotes
GO ONLINE EXTRAS

To see a video of the panel saw in action, go to our website:
ShopNotes.com

building the

Panel Saw Base



Tackling a project the size of a panel saw may seem a little daunting at first. A great way to make it more manageable is to break it down into sections. That's what you see here. This way, you can use each section to build on the next.

I started by building the fixed portions: an upper assembly that guides the saw carriage and a lower one that cradles the panel.

CARRIAGE SUPPORT ASSEMBLY

The first section to build is the upper portion of the panel saw that supports the sliding saw carriage. The carriage will ride on a 10'-length of EMT conduit, as you can see in Figure 1. This rail is supported by a long plywood panel and a handful of hardwood rail support blocks.

Although the construction isn't complicated, what's important is making sure the finished assembly is as flat and straight as possible. So I took a little extra time to find the flattest sheet of plywood to make the support panel.

After sizing the panel, I needed a way to align the support blocks perfectly. To do this, there's a groove cut in the support panel.

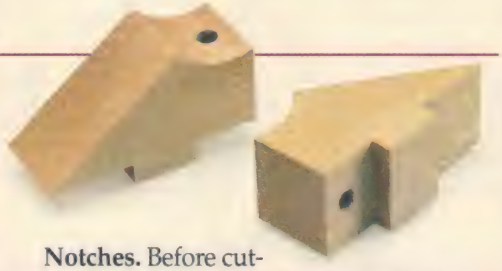
Support Blocks. As for the blocks, they're shaped to securely anchor the conduit but not get in the way of the saw carriage. You'll find all the details you need to make these parts in the box below.

Attaching the Rail. After completing the blocks, you're nearly ready for assembly. All that's left is to predrill the rail. The setup I used to drill the rail is shown on page 15.

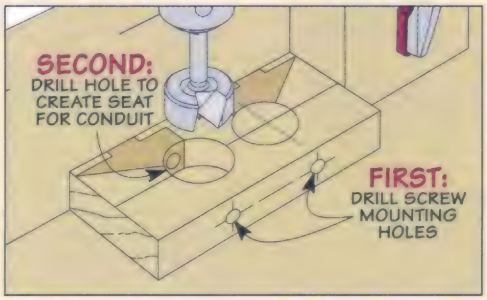
Rail Support Blocks

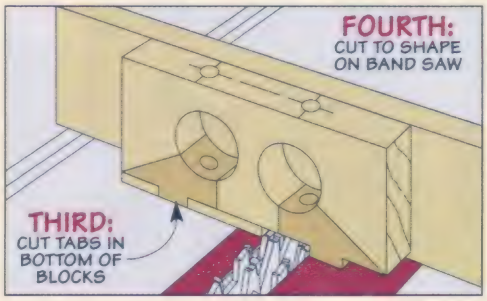
The blocks that support the long piece of conduit are pretty simple. The only thing is you want to make sure they're identical.

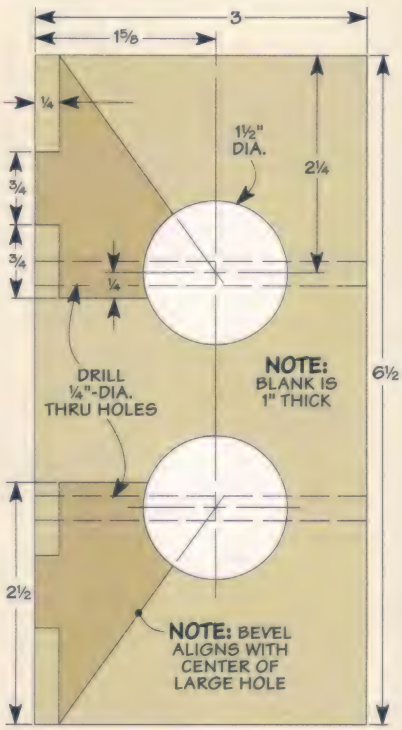
Two at a Time. I made the blocks from an oversize blank, as you can see at right. The larger blank is easier to control. The first thing to do is drill the mounting holes. Then you can drill a couple of larger holes to create the "seats" for the conduit. To do this accurately, I set up a fence and stop block on my drill press (left drawing below).

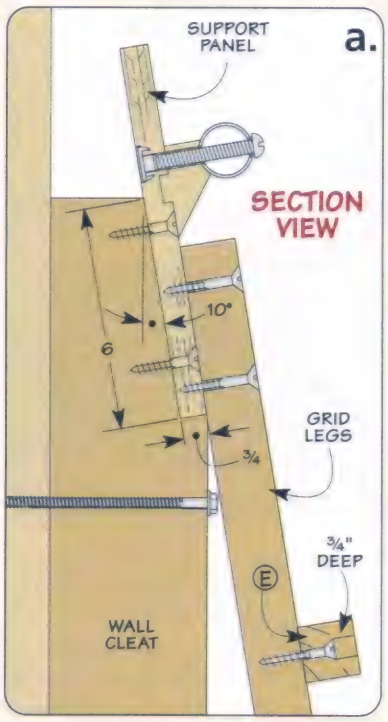


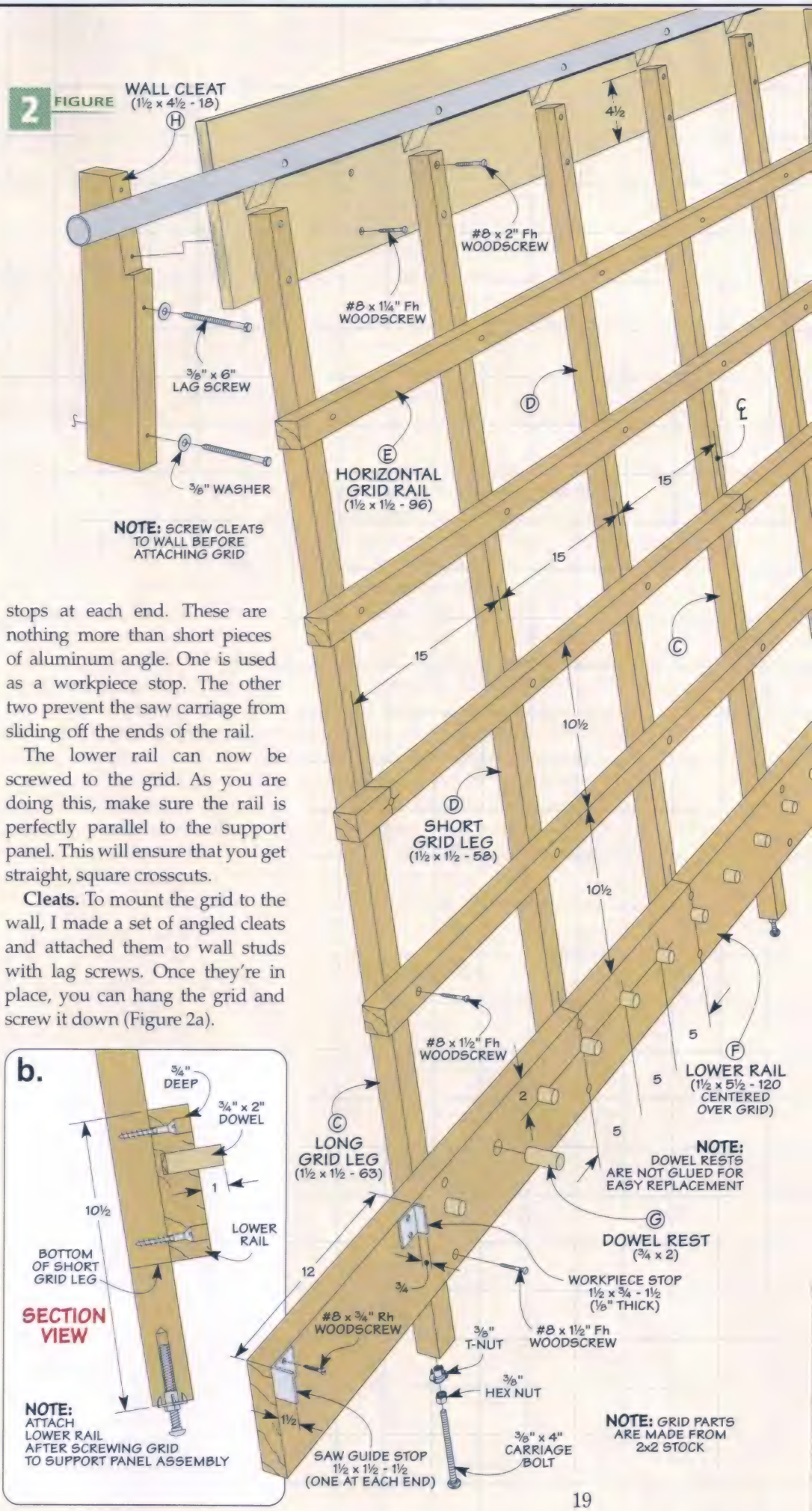
Notches. Before cutting the blocks to shape, I took the blank over to the table saw and cut notches along the bottom edge to create tabs to fit the groove in the support panel (right drawing below). Then I cut the blocks to shape on the band saw.











Then, I used T-nuts and machine screws to hold everything together.

PANEL SUPPORT GRID

The upper assembly you just completed is attached to a large grid, as in Figure 2. Besides fully supporting a sheet of plywood while it's cut, the grid also has a heavy-duty lower rail that the workpiece rests upon.

The Grid. Despite its size, building the grid won't take much time. That's because it's made from 2x2s. There are two things to point out. First, the screws are set into deep countersinks so the saw blade won't hit them (Figure 2a).

The other thing to mention is that the center and outer posts act as feet for the panel saw. Each one has a simple leveler consisting of a bolt and T-nut (Figure 2b). Once the grid is complete, you can screw it to the upper assembly.

Lower Rail. Along the bottom, you can see a wide, lower rail. This is simply a 10'-long 2x6.

Along the rail, I drilled a series of holes to hold short sections of dowel. They support the bottom edge of the plywood, as in Figures 2 and 2b. The dowels aren't glued into the holes so you can replace them if they get chewed up.

Stops. Before attaching the rail to the grid, I also installed some stops at each end. These are nothing more than short pieces of aluminum angle. One is used as a workpiece stop. The other two prevent the saw carriage from sliding off the ends of the rail.

The lower rail can now be screwed to the grid. As you are doing this, make sure the rail is perfectly parallel to the support panel. This will ensure that you get straight, square crosscuts.

Cleats. To mount the grid to the wall, I made a set of angled cleats and attached them to wall studs with lag screws. Once they're in place, you can hang the grid and screw it down (Figure 2a).

sliding Carriage

Smooth Sliding. *The carriage rides along the rail on three sets of bearings.*

At this point, the base of the panel saw is complete. The next step is to build the sliding carriage that rides on the rail. This carriage needs to have a firm grip on the rail so any cut you make is straight and true. But it also needs to slide smoothly for precise rip cuts and for easy positioning to make crosscuts.

In the drawing below, you can see all that goes into making this portion of the panel saw. It consists of an L-shaped wood assembly with a set of aluminum supports. Bearings on the supports allow the carriage to glide smoothly along the conduit rail (photo above).

Carriage Top. I started building the carriage by making the top. It's really just a thick board with a pair of angled grooves cut in it. Each groove is sized to accept a piece of aluminum angle. The End View drawing below shows you just where to make the cuts.

The exposed leg of each piece of aluminum angle has a pair of bearings bolted to it (Figure 3). To keep the saw carriage level, you'll need to make sure the holes are drilled accurately. Then to provide clearance for the bearings, I used 3/16" washers that I drilled out to 1/4".

Screw it in Place. The aluminum angles should fit snug in the grooves. But to ensure they stay in place during use, I drove a couple of screws into each piece.

Face. The bearings in the top ride on the top of the rail. But for the best accuracy and stability, the carriage needs to grab onto the bottom of the rail as well.

To do this, I screwed a plywood face to the front of the top. Then, I made a pair of aluminum angle sections to wrap around the rail, as shown in the End View below.

A Firm Grip. Although attaching this assembly of aluminum angle and bearings seems simple enough, there's one thing I should point out here. The bearings need to grab the rail with just the right

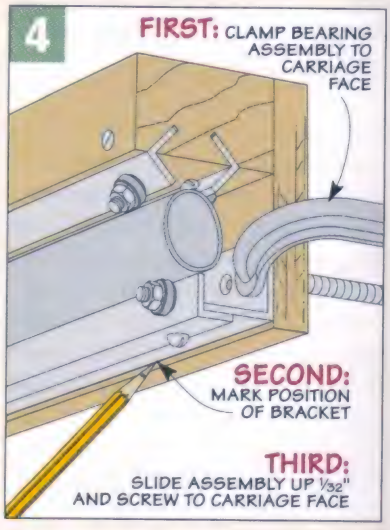
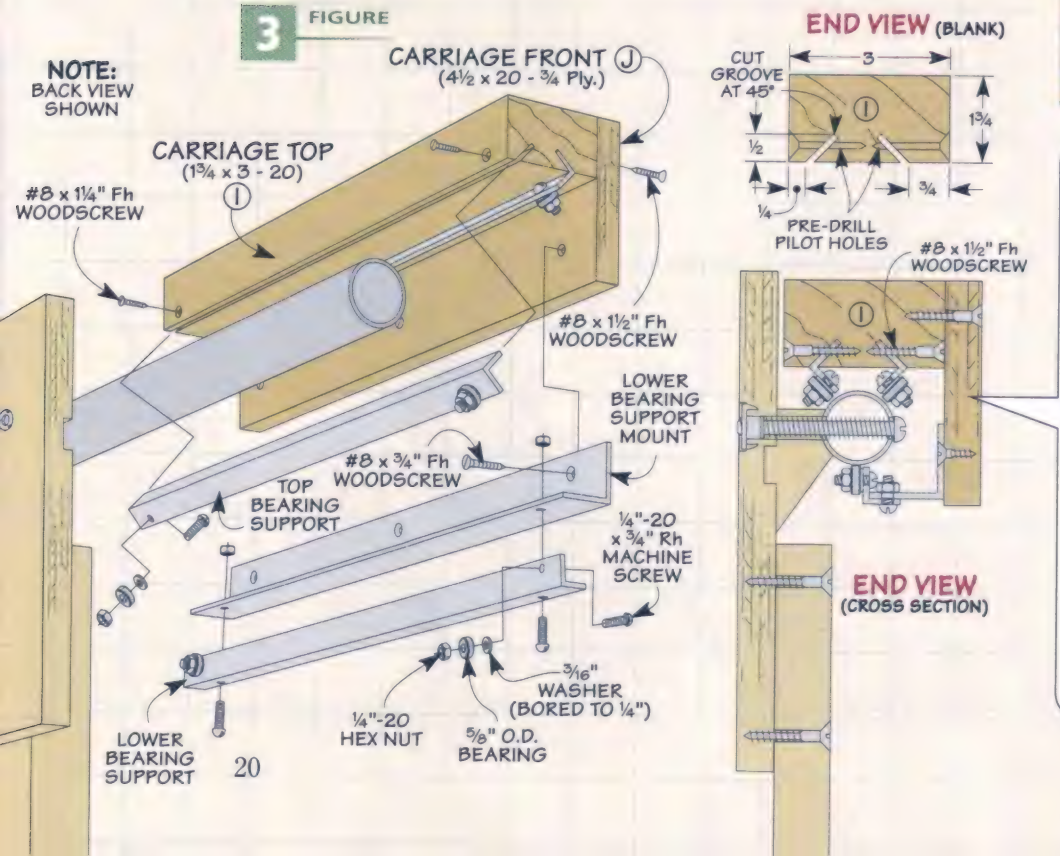
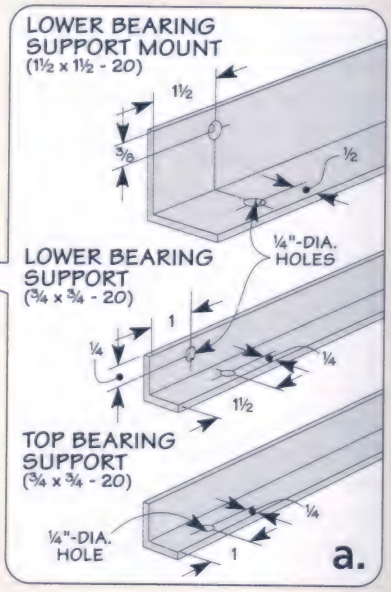


FIGURE 3





amount of pressure. If the grip is tight, the carriage will be too stiff to operate smoothly. A loose grip results in the carriage jiggling as it moves. But don't worry, there's a simple way to get just the right amount of squeeze on the rail.

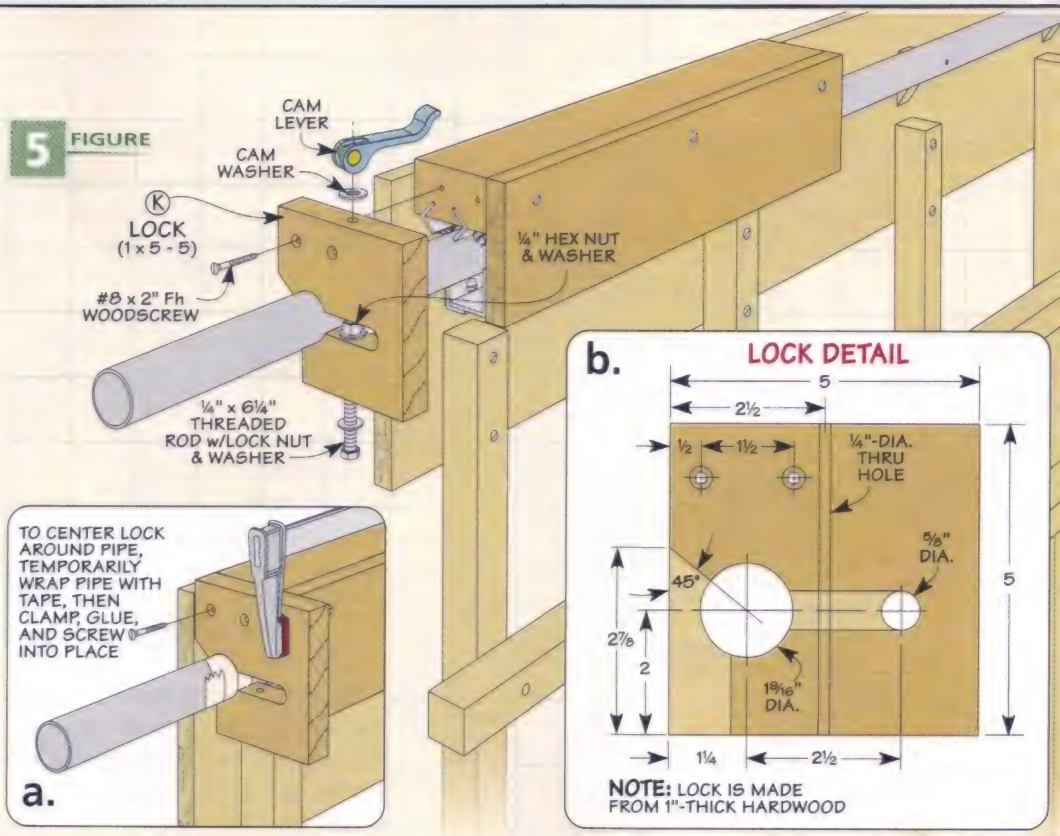
Here's how to do it. Start by putting together the lower aluminum angle and bearing assembly, but don't screw it to the face just yet. Then place the carriage assembly on the conduit rail. Now, clamp the lower bearing assembly so it just touches the rail, as in Figure 4.

Mark and Drill. With a pencil, mark the location of the aluminum angle on the carriage face, and then remove the clamps. Now, mark and drill the mounting holes so the angle is about 1/32" above the line you marked. That should give just the right pressure for a solid grip.

LOCKING ASSEMBLY

There's only one other part that you'll need to make to complete the saw carriage. And that's the lock, as illustrated in Figure 5.

This simple assembly allows you to make accurate crosscuts in a sheet of plywood by securely clamping the carriage to the rail. And you'll find that making it is pretty simple, too.



Making the Lock. In Figure 5b, you can see the lock starts as a square blank. For the lock to fit over the rail without binding, I made a hole in it that's a bit larger than the rail. This is just a matter of sanding the hole after it's drilled.

The next thing is to prevent the lock from catching on the rail support blocks as the carriage slides. You can do this by cutting away a portion of the back edge, as shown.

The final step is a relief cut. This allows the lock to flex a bit to fix the carriage in place. And to get the lock to flex and clamp down on the rail, I used a cam clamp, a bolt, and some washers, as you can see in Figure 5. Using a fast-acting cam clamp really makes setting up the saw for crosscuts fast. When this step is complete, you can screw the lock assembly to the carriage, as shown in Figure 5a.

Materials & Hardware

PANEL SUPPORT		
A	Support Panel (1)	10 x 96 - ¾ Ply.
B	Pipe Support Blocks (7)	1 x 1⅝ rgh. - 2½
C	Long Grid Legs (3)	1½ x 1½ - 63
D	Short Grid Legs (4)	1½ x 1½ - 58
E	Horizontal Grid Rails (5)	1½ x 1½ - 96
F	Lower Rail (1)	1½ x 5½ - 120
G	Dowel Rests (19)	¾ x 2½
H	Wall Cleats (2)	1½ x 4½ - 18
CARRIAGE		
I	Carriage Top (1)	1¾ x 3 - 20
J	Carriage Front (1)	4½ x 20 - ¾ Ply.
K	Lock (1)	1 x 5 - 5
SAW GUIDE & PANEL		
L	Saw Guide Panel (1)	20 x 68 - ¾ Ply.
M	Left Foot (1)	1 x ⅞ - 3½
N	Right Foot (1)	1 x ⅞ - 7
O	Saw Base (1)	16½ x 16½ - ¾ Ply.

- (1) 1¼" x 10' EMT Conduit (1½" OD)
- (7) ¼"-20 x 3" Rh Machine Screws
- (7) ¼"-20 Pronged T-Nuts
- (16) #8 x 2" Fh Woodscrews
- (51) #8 x 1½" Fh Woodscrews
- (3) ⅜"-16 Pronged T-Nuts
- (3) ⅜"-16 Hex Nuts
- (3) ⅜"x 4" Carriage Bolts
- (1) 1½" x 1½" - 36" Aluminum Angle (⅛" thick)
- (1) ¾" x ¾" - 72" Aluminum Angle (⅛" thick)
- (1) 1½" x 48" Aluminum Bar (⅛" thick)
- (10) ¼"-20 x ¾" Rh Machine Screws
- (15) ¼" Hex Nuts
- (6) R4 Steel Bearings (¼" ID, ⅝" OD)
- (6) 3⁄16" Washers, bored to ¼"
- (11) #8 x 1¼" Fh Woodscrews
- (2) #8 x 1½" Rh Woodscrews
- (17) #8 x ¾" Fh Woodscrews
- (1) ¼" x 2" Lag Screw
- (2) 1¼"-Dia. Steel Patio Door Rollers
- (1) ¼" x ¾" Hex Bolt
- (1) ¼" x 1¼" Hex Bolt
- (1) ⅛" x 3⁄16" Awning Pulley
- (2) 9⁄16" x 16½" x .054" Extension Springs
- (1) 7' x 1⁄16" Braided Cable
- (2) 1⁄16" Compression Cable Clamps
- (8) #8 x ¾" Rh Woodscrews
- (12) #8 x ½" Rh Woodscrews
- (3) 48" T-Tracks
- (4) 5⁄16" x 1" Flange Bolts
- (4) 5⁄16" Washers
- (4) 5⁄16" Through Knobs
- (1) 5⁄16" Cam Lever w/Washer
- (1) ¼"-20 x 6¼" Threaded Rod
- (1) ¼"-20 Nylon Lock Nut
- (2) ¼" Washers
- (2) Rubber-Insulated Wire Clamps
- (3) Toggle Clamps w/Screws
- (4) ⅜" x 6" Lag Screws
- (4) ⅜" Washers
- (1) 4' Self-Adhesive Measuring Tape
- (1) 12' Self-Adhesive Measuring Tape
- (1) 12" x 12" Plastic Laminate

building the Saw Guide

All that's left to build is the business end of the panel saw — the saw guide and saw base. These are both shown in Figure 6 at left.

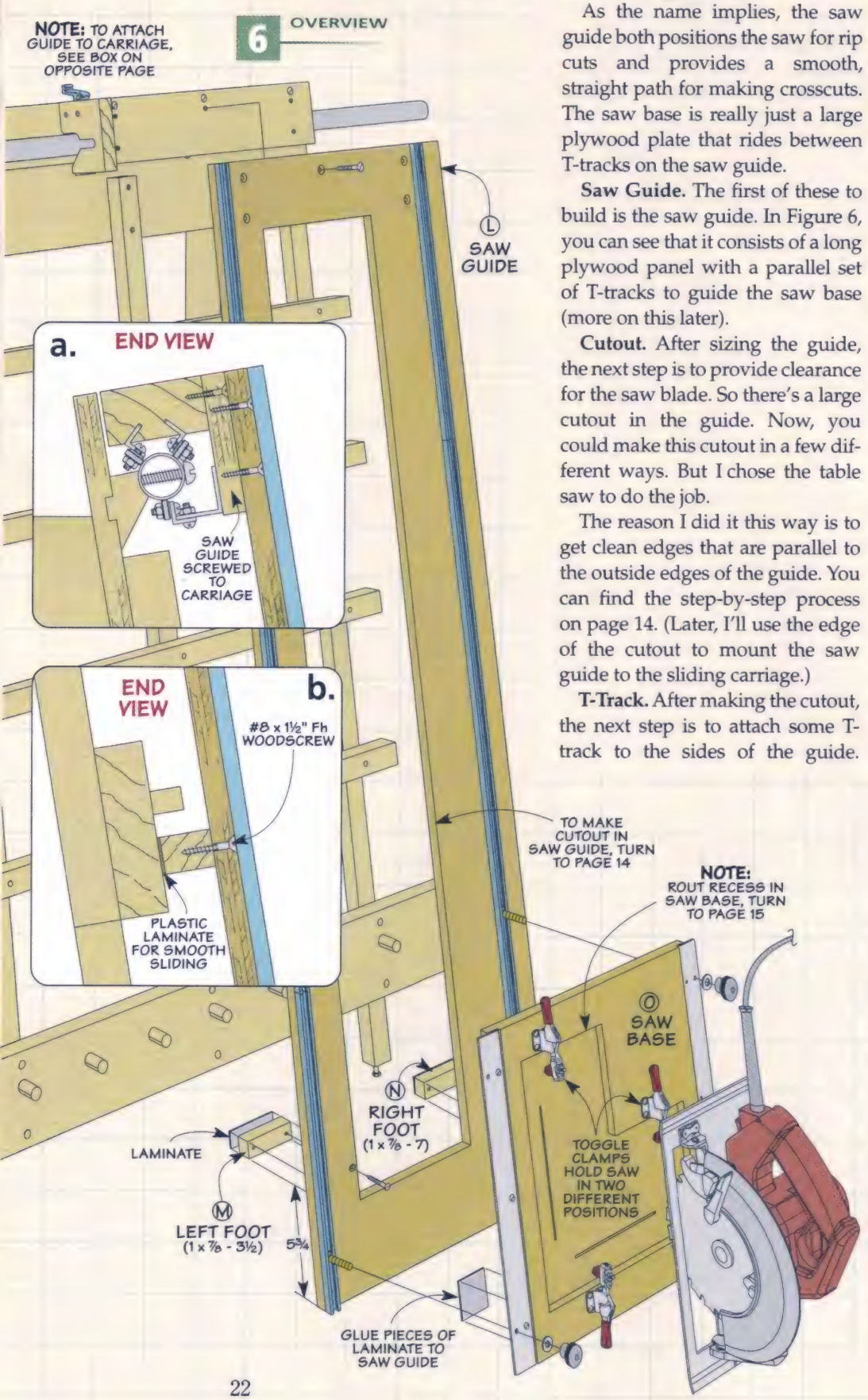
As the name implies, the saw guide both positions the saw for rip cuts and provides a smooth, straight path for making crosscuts. The saw base is really just a large plywood plate that rides between T-tracks on the saw guide.

Saw Guide. The first of these to build is the saw guide. In Figure 6, you can see that it consists of a long plywood panel with a parallel set of T-tracks to guide the saw base (more on this later).

Cutout. After sizing the guide, the next step is to provide clearance for the saw blade. So there's a large cutout in the guide. Now, you could make this cutout in a few different ways. But I chose the table saw to do the job.

The reason I did it this way is to get clean edges that are parallel to the outside edges of the guide. You can find the step-by-step process on page 14. (Later, I'll use the edge of the cutout to mount the saw guide to the sliding carriage.)

T-Track. After making the cutout, the next step is to attach some T-track to the sides of the guide.



▲ *Two-Position Base. The circular saw clips into the base with toggle clamps for ripping and crosscuts.*

These will act like railroad tracks to help the saw run perfectly straight during a cut. The tracks also add rigidity to the assembly.

There's one other thing about attaching the T-tracks to point out. Since the guide is longer than the 48"-long T-track, you'll need to use two pieces for each side of the guide. And to keep the saw base from snagging on the joints, it's a good idea to stagger the joints — one at the top and the other near the bottom.

You can see how I screwed the tracks to the guide in Figure 7. The key is to position the tracks parallel so the saw base can slide smoothly.

To do this, I used a plywood spacer. (Later, you'll make the saw base out of this spacer.) After attaching one track flush to the edge of the guide, I set the spacer down next to it, and then screwed the other track in place.

Feet. Before attaching the guide to the saw, I made a pair of feet for the bottom of the guide. These feet support the guide so it's parallel with the piece being cut.

But plain wood feet wouldn't slide smoothly on the lower rail. So to keep the sliding assembly running as smooth as possible, I glued

a piece of plastic laminate to the bottom of each foot (Figure 6b).

Mounting the Guide. At this point, you're ready to attach the guide to the carriage. To ensure accuracy, you want to make sure the guide is mounted square to the lower rail. You can see how to do this in the box below.

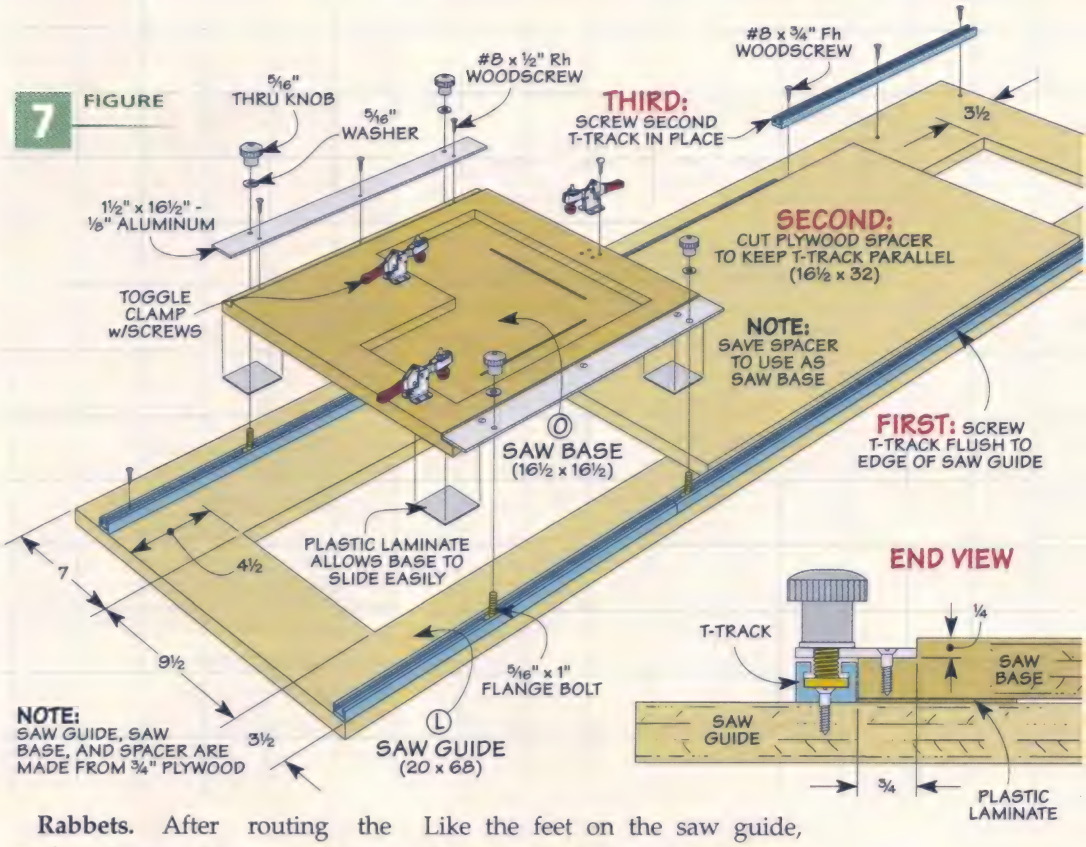
SAW BASE

The other part of the saw guide system to make is the saw base. It fits between the T-tracks mounted on the guide, as in Figure 7.

This extra-large baseplate has shallow pockets in it to hold the circular saw in one of two positions. One great feature of the base is that the saw is attached with toggle clamps. This lets you quickly reposition the saw to switch from ripping to crosscutting (or vice versa).

Making the Base. To make the base, start with the spacer you made earlier. Then cut it to final size, as shown in Figure 7.

To provide enough depth of cut for the saw, I routed shallow pockets in the base. These have the added benefit of holding the saw in position for cutting. Turn to page 15 to see how to do this.



Rabbets. After routing the pockets, I cut a rabbet on each side of the saw base. The rabbets are sized to hold a piece of aluminum bar stock. The aluminum is screwed to the base and drilled to accommodate the flange bolts, washers, and knobs used to attach the base to the T-tracks.

The last things to add to the base are a few pieces of plastic laminate. Like the feet on the saw guide, these are attached to the underside of the base so it slides smoothly along the guide (End View above).

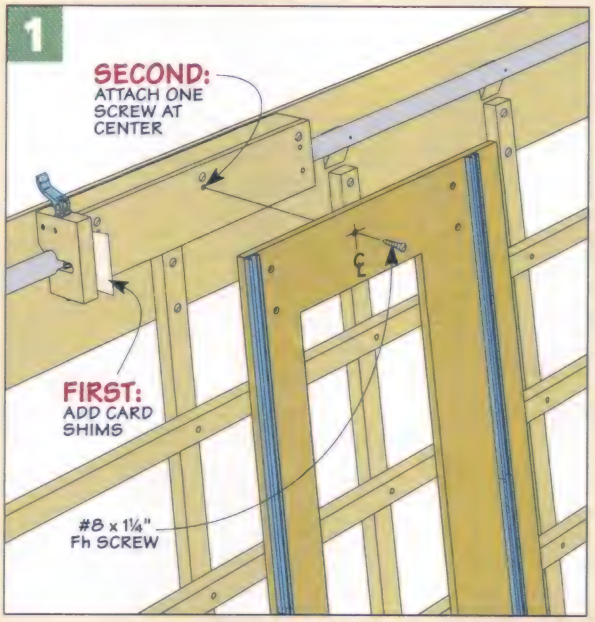
A Few Improvements. At this point, the panel saw is pretty much complete. And you could put it to use as is. But you'll find that you'll get better results and have greater control if you add the extras shown on the next two pages.

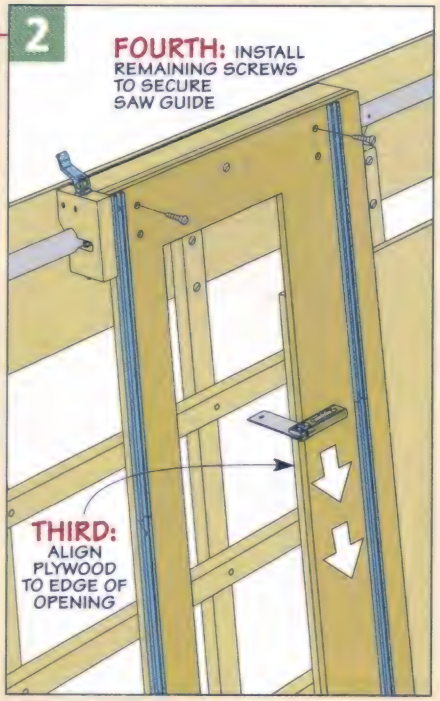
Square-up Saw Guide to Plywood

To make sure the panel saw cuts square, you need to take extra care when attaching the guide to the carriage. The two drawings at right show the steps I took to mount it.

Pivot Point. With a single screw, attach the guide in the center to act as a pivot point (Figure 1). A couple of playing cards act as shims to give you some room for adjustment.

Alignment. Next, place a sheet of plywood with a square edge on the lower rail. Using a square, pivot the guide so the inner edge of the cutout is flush all along the edge of the plywood panel. Once the guide is square, you can drive a few more screws into the carriage to lock the guide in place (Figure 2).





completing the
Panel Saw

Getting the panel saw ready for action is just a matter of adding a few details. These will make the saw easier to control and more accurate.

Supporting the Saw. With the saw in place on the base, it can be a bit heavy during use. To lighten the load so it's easier to use, I made a "suspension system," as you can see in the photos at right.

It's basically a spring and pulley setup that acts like an old-fashioned window weight to balance the weight of the saw. This way, the saw will be easier to manage as you make a crosscut.

To hold the springs in place, I used a left over piece of T-track. You can make "hooks" for the springs in the T-track with a hack saw and file, as you can see in the lower photo at right and Figure 9a. To connect the springs to the saw base, I used a system of pulleys, brackets, and a strong, braided cable.

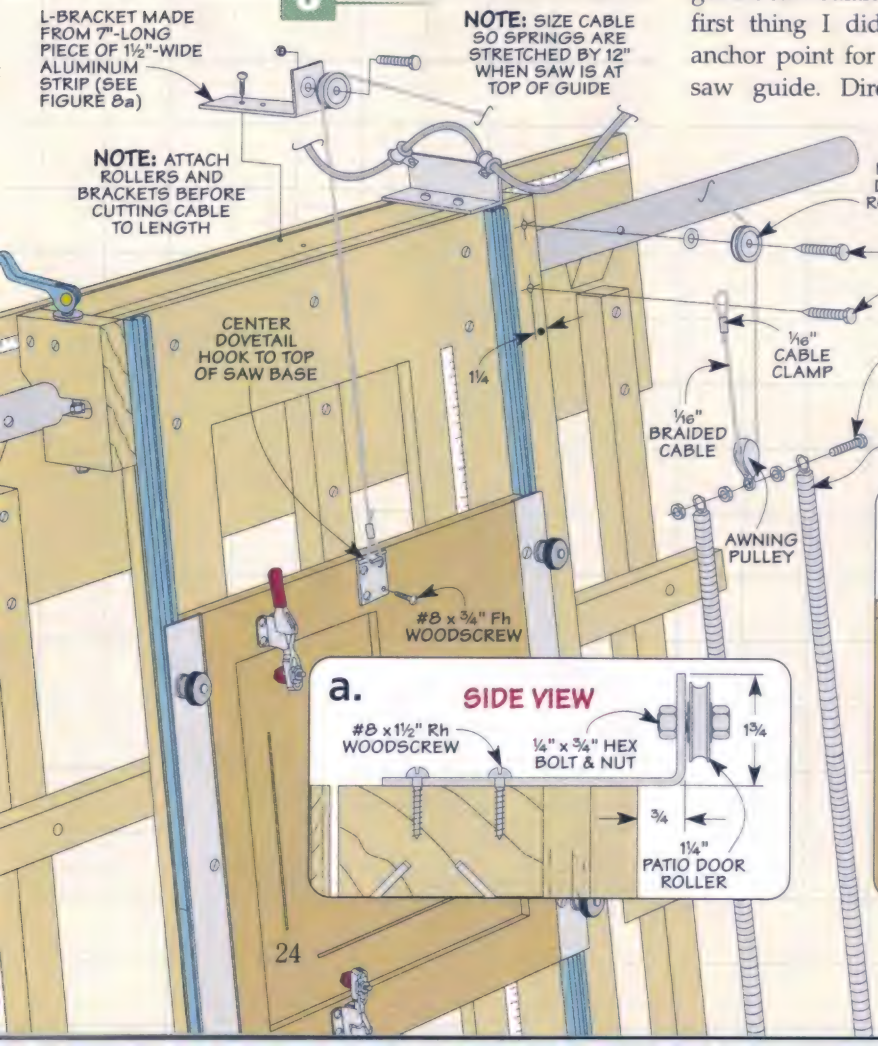
Cable Hook. *The cable is attached to the saw base with a hook made from a piece of aluminum angle.*

► ***Counterbalance.*** *A simple system of pulleys and springs carries the weight of the saw making cuts almost effortless.*

Pulleys. But before cutting the cable to length, it's a good idea to position the hardware so you can get the saw balanced just right. The first thing I did was locate the anchor point for the cable on the saw guide. Directly above this point, I mounted a pulley that redirects the cable after it comes up from the springs. This pulley is a patio door roller that is attached to the saw guide with a lag screw.

Another patio door roller is mounted to an aluminum L-bracket

FIGURE 8



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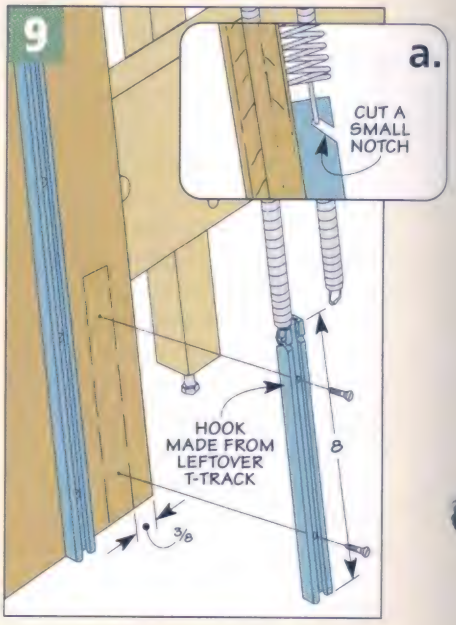


that's screwed to the top of the carriage assembly, as in Figure 8a.

The anchor point for the other end of the cable is an aluminum bracket located on the saw base. To make sure the cable won't come off the bracket, I shaped the hook to look like a dovetail, as you can see illustrated in Figure 8b.

With all the connection points set, the last thing to do is to connect the springs to a pulley. For this, I used a bolt and a few nuts (Figure 8).

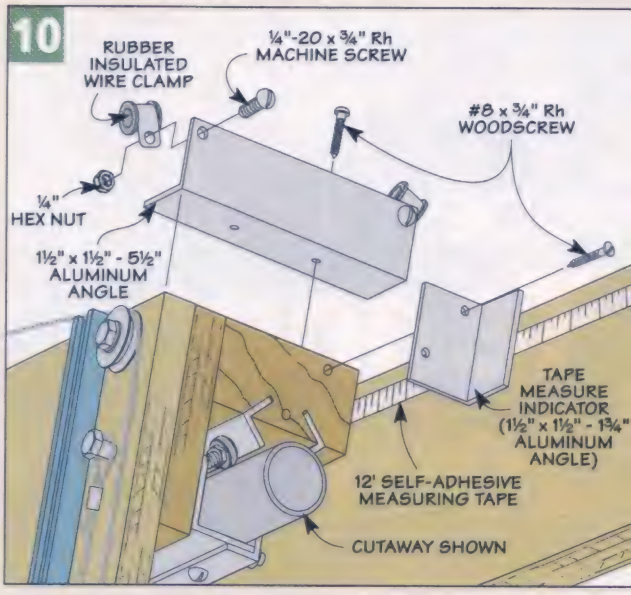
Size the Cable. Now, you're ready to connect all the parts with a length of cable. The cable needs to be sized so that the springs balance the weight of the saw.

Here's how I did this. First, I attached the circular saw to the base and positioned the base about an inch below the top bracket. Then I made a loop in one end of the cable and connected it to the anchor point on the guide.

After threading the cable through the pulley on the springs and around the upper rollers, pull the cable to extend the springs about 12". Now, mark the cable where it meets the hook on the saw base. Finally, you can release the tension, cut the cord to length, and then finish it with a loop.

Cord Guide. The spring system takes care of the weight of the saw. But I wanted to keep the power cord out of the way as well. This way, it won't get snagged in the middle of a cut.

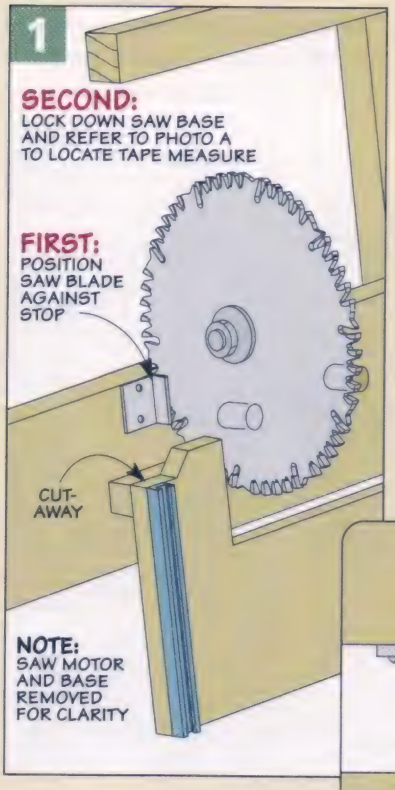
To do this, I used a set of rubber-lined clamps attached to a bracket on the carriage, like you see in Figure 10. This allows the power cord to drape behind the grid, safely out of the way.

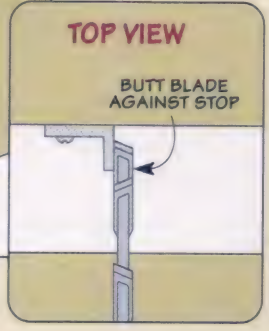


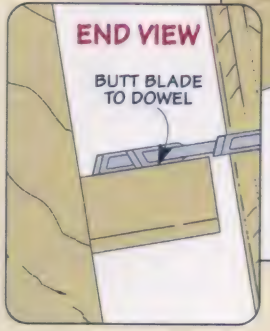
Measuring Tapes. Finally, in the box below, you can see how I added a pair of measuring tapes to set up for accurate cuts.

Installing the Measuring Tapes

Making accurate cuts on the panel saw depends on locating the measuring tapes precisely. As you can see in the drawings below, there's a simple way to do this.

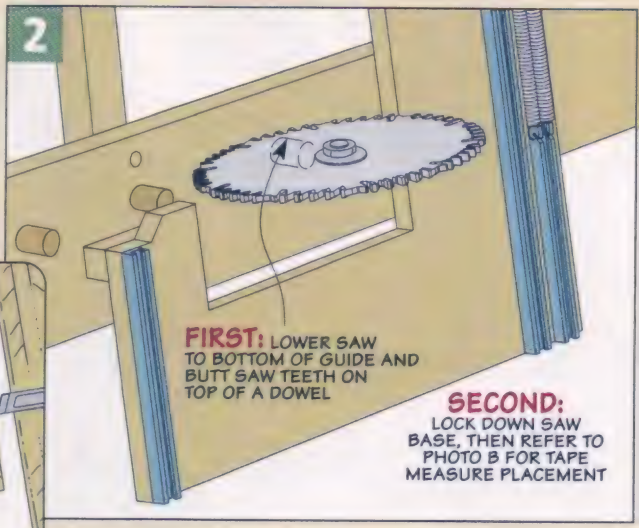






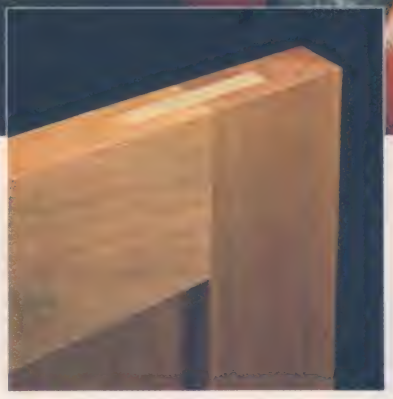
Crosscuts. I placed the tape for making crosscuts on the top rail support (photo at right). To indicate the saw's position, I screwed the aluminum indicator to the carriage assembly. Then, to find the "zero" position, you'll need to slide the saw down and align the edge of the blade against the aluminum stop on the lower rail. You can see this in the Top View of Figure 1. This is the starting point, and you can now press the tape in place.

Rip Cuts. The process is almost identical for rip cuts. After putting the saw in the rip position, rest the edge of the blade on the top of a dowel (Figure 2). Here, I placed the tape on the saw guide and used the top of the saw base as the reference line, as in the far right photo.



open floating Tenon Joinery

Mortise and tenon made easy. All it takes is one router table setup.



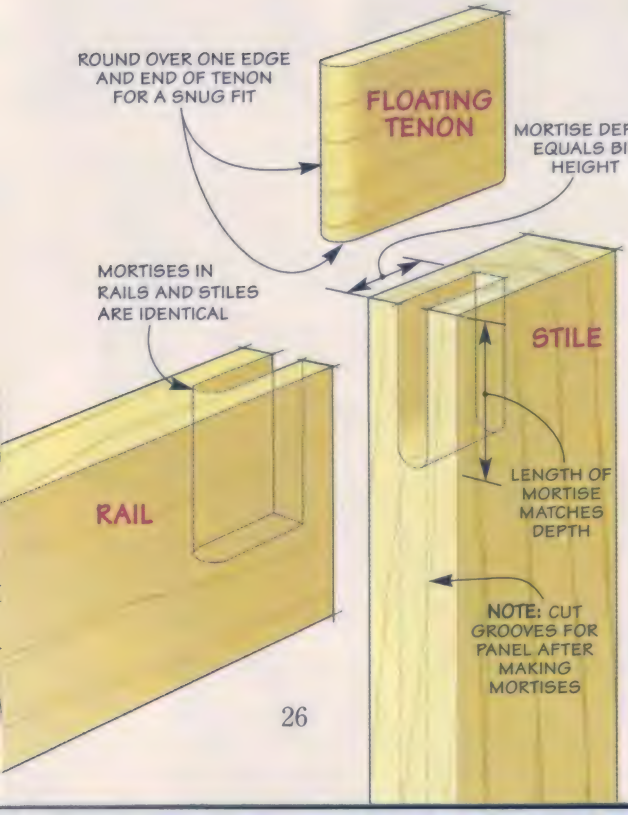
When I'm building large frame and panel assemblies or doors, I turn to traditional mortise and tenon joinery for long-lasting strength. But for smaller work, I like to use a modified mortise and tenon joint. Most of the work is done at the router table. And, best of all, this joint provides a lot of strength *and* is quick to make.

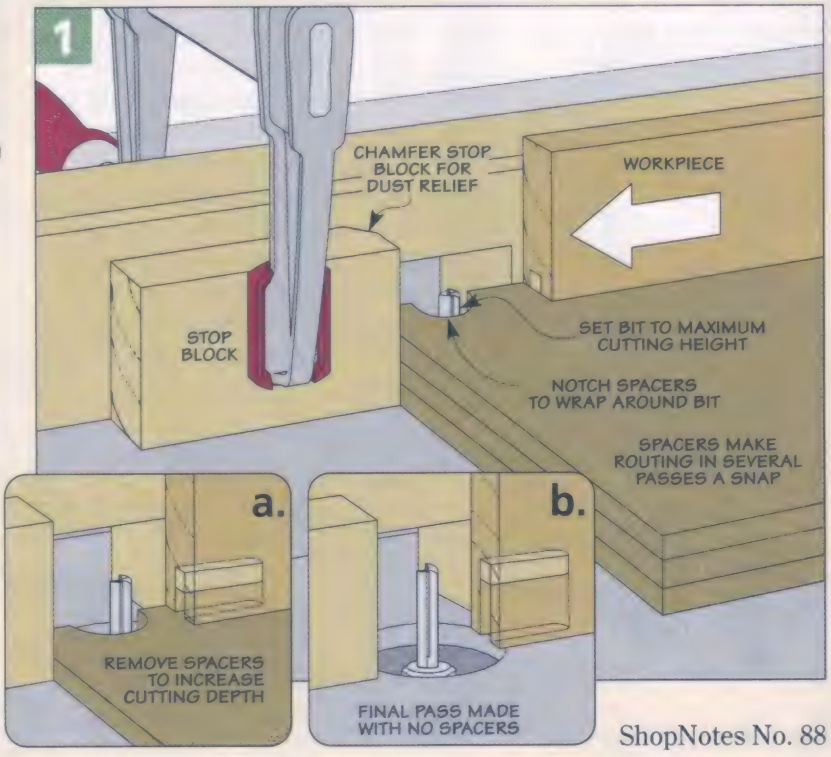
In a traditional mortise and tenon joint, you need one setup to make the mortises and a different one for the tenons — which can be time-consuming. To streamline the process, I rout an identical mortise in each mating piece. The parts are then joined with a "floating" tenon. This means you only have one setup for making the mortises.

ROUTING MORTISES

With an idea of how the joint works, you're ready to get set up and start routing. All you'll need is a regular straight bit. And for ¾"-thick stock, a ¼"-dia. bit is just the right size.

Setting Up. Figure 1 gives you a good overview of the router table





setup I use. But there are a few important details to point out.

First, the bit needs to be centered on the workpiece. This way, the mating pieces will be flush. The box below shows you how.

Next, you can set the bit height. For the largest (and strongest joint), I set the bit to its full cutting length.

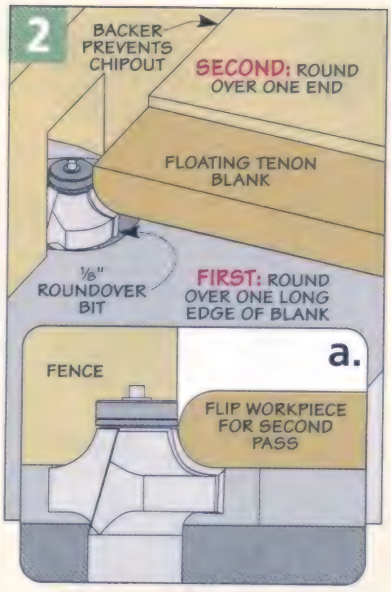
Spacers. However, making a full-depth cut like this puts a lot of stress on the bit and router motor. So I limit each cut to ¼" deep and make multiple passes.

The problem here is having to reach under the table to adjust the height of the router. This is time-consuming, and can sometimes lead to a "stepped" mortise where the sides aren't smooth and even.

So to get the best results, I rely on a set of ¼" hardboard spacers to control the depth of cut. You increase the depth of cut simply by removing a spacer (Figure 1a).

Stop Block. The last set-up step is to clamp a stop block to the router table fence. This way, you'll get identical mortises in every part. To get the strongest joint, the stop block should be set to rout a mortise that matches the bit height.

Start Routing. Now, you can turn on the router and start making mortises. One of the nice things about this joint is that the parts are all routed the same way. So you can do everything assembly-line style.

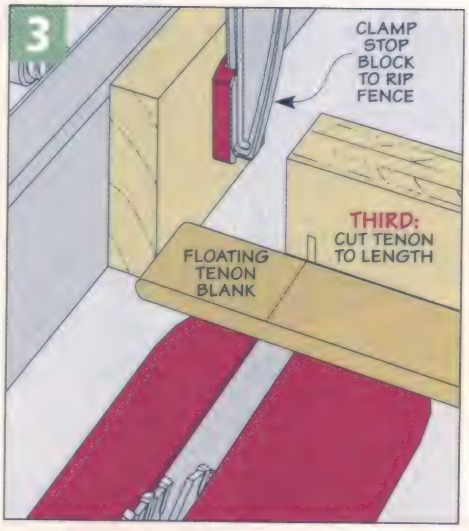


FLOATING TENONS

With all the mortises routed, you can move on to making the floating tenons. You can even "show-off" the tenon by using a contrasting wood (photo on the opposite page).

Sizing Tenon Stock. To make it easier to work on the tenons, I do most of the shaping on an oversize blank. To make assembly easier, the tenon blank is sized for a slip fit in the mortises. I also cut it extra wide so that I can trim the tenons flush after the frame is glued up.

Making the tenons involves a little "two-step" between the router table and table saw. After rounding over one long edge, you'll then round over one end of the tenon blank, as in Figure 2. This way, the tenon will seat tightly in the rounded mortise.



The second step is to cut the tenon to length at the table saw. To size tenons identically, I clamped a stop block to the rip fence and cut the tenon to length (Figure 3).

Panel Groove. At this point the the joinery is complete. If necessary, you can cut a groove in all the parts to hold a panel.

Assembly. Finally, you're ready to assembly the frame. You can see how I clamp it up in the photo on the opposite page. A pipe clamp pulls the joint together. A second clamp over the joint keeps it aligned. When the clamps come off, you can trim the tenons flush with a chisel and sandpaper.

ShopNotes GO ONLINE EXTRAS

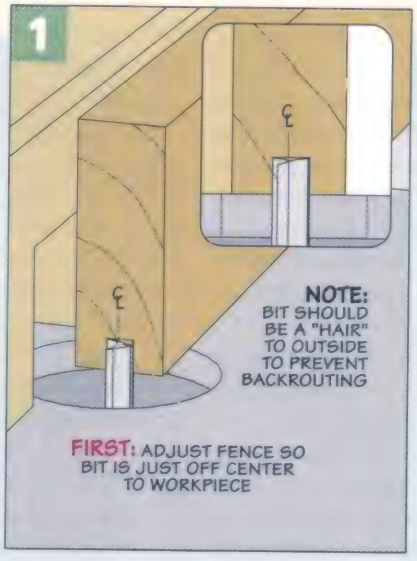
View a video on this technique by going to our website at: **ShopNotes.com**

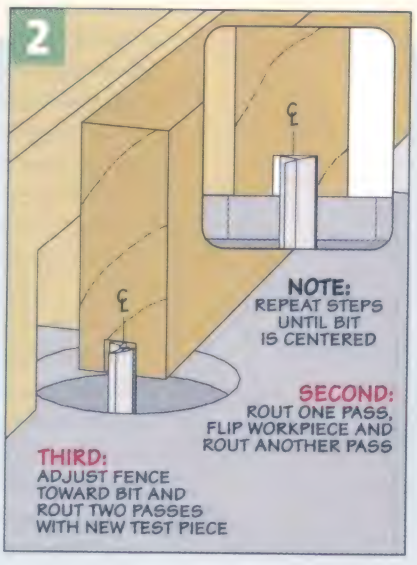
Router Bit Setup: Centering

Your goal in making a frame and panel assembly is to have the mating parts fit flush. In order to do that, the router bit needs to be accurately centered on the workpiece. Here's an easy, no-measure way to do this.

Start by "eyeballing" the bit as close to the center of a short test piece as possible and a hair toward the outside edge (Figure 1). Now, make a pass, flip the workpiece end for end and make a second pass (Figure 2). This creates a groove that's slightly wider than the bit.

To center the bit, gently nudge the fence closer to the bit and make a set of passes on a new test piece. You'll know the router bit is dead center when it doesn't remove any additional material on the second pass.





weekend workshop

Storage, organization, and portability — these stacking totes have it all.

stackable Shop Totes

▲ *Mating Parts. Stacking the totes is just a matter of slipping one tote over the handle of the one below.*

Storing hardware in the shop is always a challenge. And finding an easy way to get that hardware right where you need it — along with the hand tools to do the job — is another.

Stacking Totes. The solution to both problems is the totes you see above. You can customize them for hardware or tools. And storing a lot of hardware in a small area of your shop is a snap since they stack on top of one another.

To do this, the center of each tote is designed with an open pocket. This allows the handle of one tote to slip up inside the pocket, as in the inset photo at right.

Designing the Tote. As you can see in the drawing on the opposite page, each tote consists of only a few basic parts. And each one is held together with simple joinery. Still, there are a couple things to keep in mind as you work.

For starters, be sure to have the storage bins you plan to use in hand before you begin. I sized the tote to accept four of the small, *Akro-Mils* bins on each side (Sources, page 51). Other storage bins may vary in size, so a little adjustment may be necessary to get the bins to fit.

Another thing to keep in mind is that you'll probably want to make a number of these totes. So it's a good idea to make all similar parts at the same time to ensure each tote is sized identically.

Ends & Dividers. I started on the tote by cutting the ends to size from ½" plywood, as illustrated in the drawing on the opposite page. Once that's complete, the next step is to connect the ends with a pair of center dividers and bottoms.

After sizing these parts, you can start to work on the joinery that holds everything together. In the Top View at right, you can see where the dividers slip into a pair of

spaced dadoes cut in the ends. This creates an opening for the handle and, at the same time, forms the pocket for the handle below that allows you to stack the totes.

As you locate the dadoes, it's important to match the spacing to the thickness of the material used for the handle. (I used ¾" plywood to provide a solid grip.)

With the dadoes complete, you can turn your attention to the grooves and tongues that need to be cut in the ends, dividers, and bottoms. Everything you need for this is shown in the drawing at right.

You're almost ready to assemble the tote, but there's a couple more things to do. First, cutting a small miter on the top outside edges of the ends eases the sharp corners.

Second, you'll want to widen the pocket in the bottom of the tote to provide a little "wiggle" room for the handle. This way, the totes won't stick together. To do this, I cut a shallow rabbet on the inside face of each divider. Shop Short Cuts on page 14 shows how to do this.

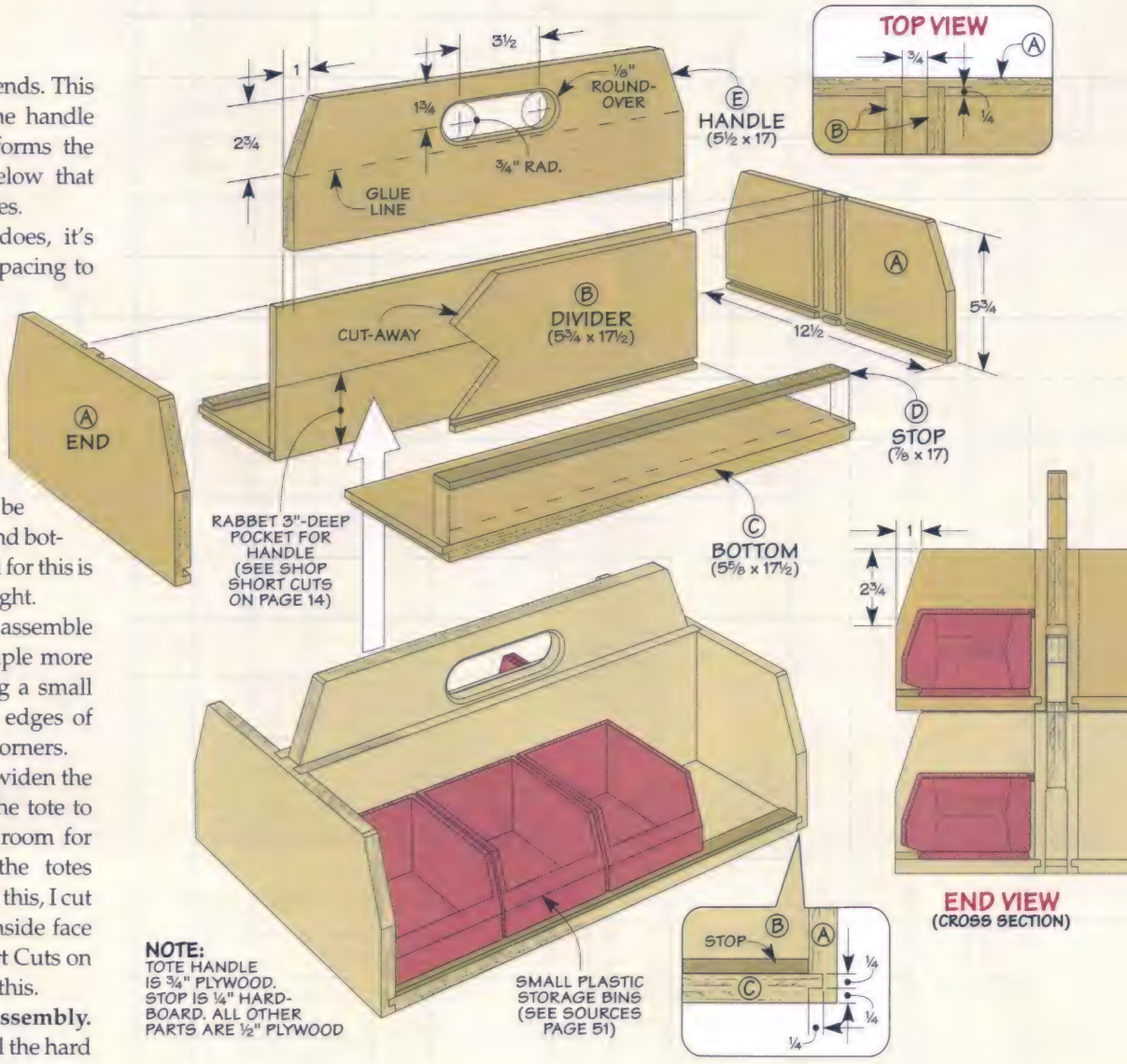
Completing the Assembly. After gluing up the tote, all the hard stuff is out of the way. The next step is to add a pair of stops and the handle shown in the drawing.

The ¼" hardboard stops prevent the plastic bins from sliding out as you carry the tote around. After cutting the stops to size, they're glued to the front edges of the tote bottoms (drawing above).

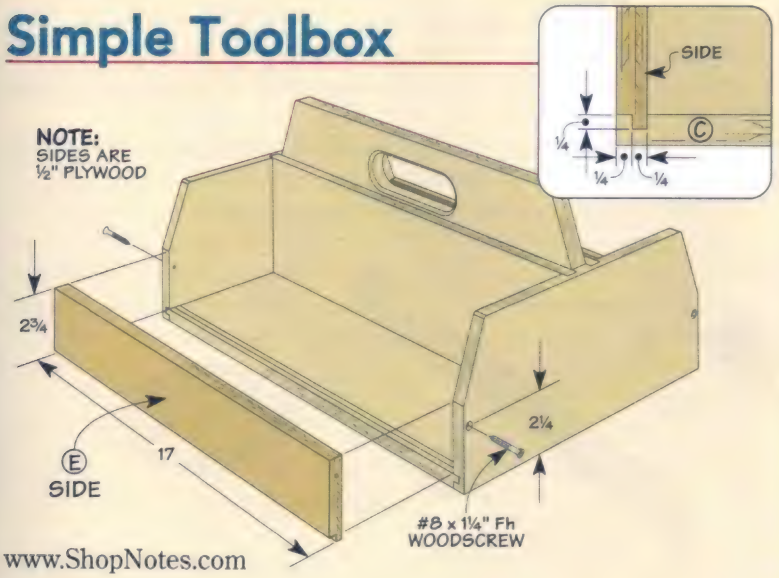
The last part to complete is the handle. After cutting it to fit the opening in the tote, you'll need to do a little shaping work. Drilling a couple holes and removing the waste in between forms the handle opening. And a little sanding and a small roundover make for a comfortable grip. The last thing to do before gluing the handle in place is to miter the top edges. Besides easing the sharp corners, it makes it easier to guide the tote in place as you stack them together.

Toting Tools. Although you could build just enough totes for storing and hauling all your hardware around, you might want to modify one of them for carrying the tools you'll need for the job as well. And as you can see in the box at left, the changes aren't all that difficult.

At this point, all that's left to do is gather up all your hardware, organize each tote just the way you'd like, and then stack them neatly away until you need them.



Simple Toolbox



Old and New. The vintage plane on the left was manufactured with a jeweled finish. We duplicated the finish on the plane below.

decorative Metal Jeweling

Not long ago, I came across an interesting old hand plane. It was an infill plane made by *Norris*, a well-known English plane manufacturer. But the thing that caught my eye was the sides of this plane. They were engraved with what appeared to be a "fishscale" pattern, as in the photo above.

The technique used to create this pattern is known as jeweling, engine turning, or spot finishing. It's a process that has been around for decades, and was often used on guns, automobile dash panels, and even on the nose cone of the famed aircraft, *The Spirit of St. Louis*.

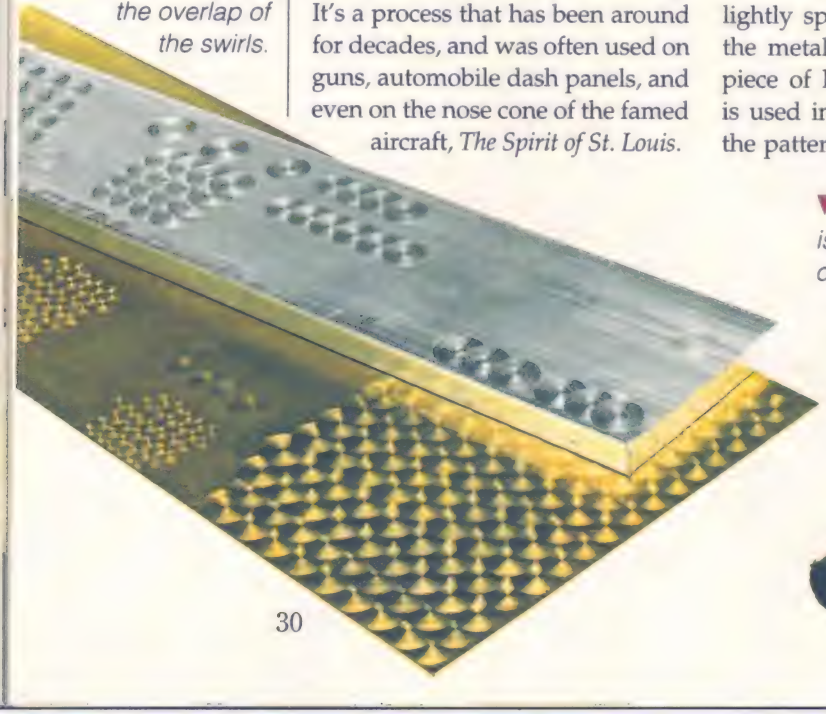
Although it looks complicated, the technique is actually fairly straightforward. The pattern is made by "grinding" a series of overlapping swirls on the surface of the metal. And you can do this on a standard drill press.

Materials. There are a couple of different ways to create the swirls. One is to mix emery powder or silicon carbide powder with oil to create an abrasive "slurry" that is lightly spread over the surface of the metal. Then a dowel with a piece of leather glued to the end is used in the drill press to grind the pattern into the metal.

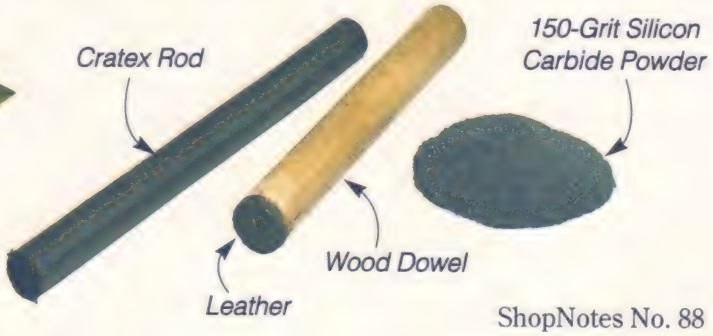
Another method is to use a rod of rubberized abrasive (commonly known as *Cratex*). This rubberized abrasive is formed into different diameters of rods. The advantage of this method is that the abrasive is already in the rod, so you don't have to deal with mixing up an abrasive slurry. I used a medium-grit, $\frac{3}{8}$"-dia. rod to complete the jeweling on the plane shown in the photo above. (For sources of *Cratex* rods, see page 51.)

Metal Prep. Before you can start grinding the swirls, you need to remove any scratches from the surface of the metal. If you don't,

Experiment. You can change the look of the jeweling by using different diameters of rods or varying the overlap of the swirls.



Materials. Aside from a drill press, all you need for jeweling is a cratex rod. Or you can use some oil and abrasive powder on a wood dowel with a piece of leather glued to the end.



Smooth Start. For the best results, first sand and then buff the metal smooth before jeweling.

Swirls. Start in one corner of the workpiece and make rows of overlapping swirls.

these will show through the swirls and ruin the effect of the pattern. So I start by sanding and then buffing the metal until it's smooth (photo above). This will give you better-looking results.

Making the Swirls. Once the metal has been buffed out, you can start creating the pattern using the drill press. To do this, simply chuck up a short (2 or 3"-long) piece of the rod in your drill press. Then with the drill press running at a medium speed (around 1000 RPM), lower the chuck until the rod contacts the metal and creates a round swirl.

You don't have to press down on the metal very hard or for very long. In fact, a light touch makes a better swirl than heavy pressure.

Create a Pattern. Now it's just a matter of making rows of overlapping swirls. The trick here is to keep the pattern consistent. To do this, I used a fence to keep the rows of swirls straight and even (upper right photo). And I laid out some index marks along the edge of the fence to help keep the spacing consistent (lower right photo).

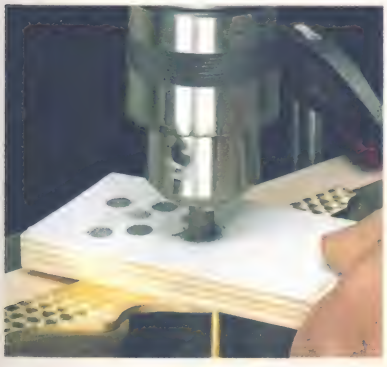
I overlapped each swirl by about one third of the diameter. And I staggered each row. But you can experiment with different spacing as well as different rod diameters.

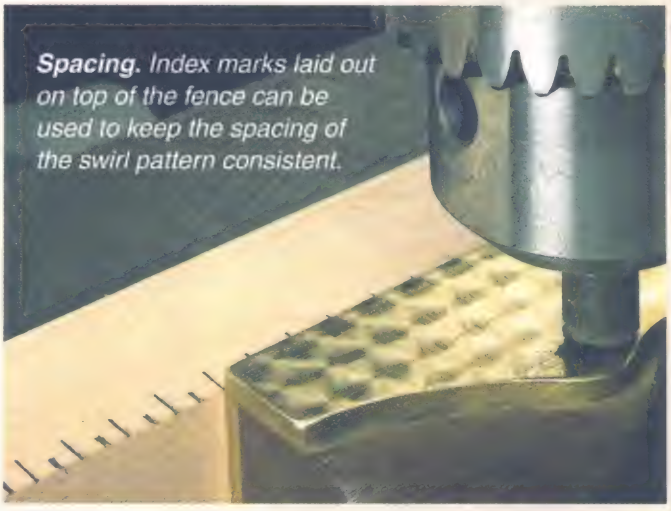
Dress the End. Every so often (after 10 or 20 swirls), it's a good idea to dress the end of the rod on a piece of sandpaper to expose fresh abrasive particles (photo at left). This helps to keep all the swirls looking identical.

It's also important not to go back over an area that you've already covered. But if you should mess up, you can sand the metal smooth and start over again.

Once you get the hang of it, the process doesn't take long and the results are pretty impressive.

▼ **Dress.** *To expose fresh abrasive, dress the end of the rod on a piece of sandpaper every so often.*





Spacing. Index marks laid out on top of the fence can be used to keep the spacing of the swirl pattern consistent.

Small Parts:
Jeweling Kit

While searching for information on jeweling, I came across a jeweling kit designed specifically for gunsmiths. Instead of using a dowel or abrasive rod to create the swirl marks, this kit uses small wire brushes along with an abrasive compound (photo).

The main advantage of this kit is that it allows you to jewel objects with hollow or curved surfaces. The wire bristles of the brush can conform to the surface of the object even if it's not flat. The brush is inserted into a spring-loaded holder that mounts in the drill press chuck. Rubber O-rings or heat-shrink tubing can be slipped over the end of the brush to prevent the bristles from flaring out, creating a smaller diameter swirl. For more information on this kit, see sources on page 51.

▼ **Jeweling Kit.** *This kit uses wire brushes and an abrasive compound to create the swirls.*

dovetailed Shoulder Plane

Make an heirloom tool and learn the secret to creating double dovetails in metal — it's easier than you think.

I've always been fascinated by old, metal hand planes. Especially ones that were made using dovetails to join the sides of the plane with the sole, like the shoulder plane in the photo above. If you look carefully, you'll see that they're really "double" dovetails. Both the sides and the sole have flared "tails." Now this seems like it would be impossible to put together. But these dovetails are cut almost the same way as regular dovetails. The tails are cut into the brass sides and the pins are cut into the steel sole. But there's a little trick to make the pins look like tails to create the double dovetails. I'll explain more about this later.

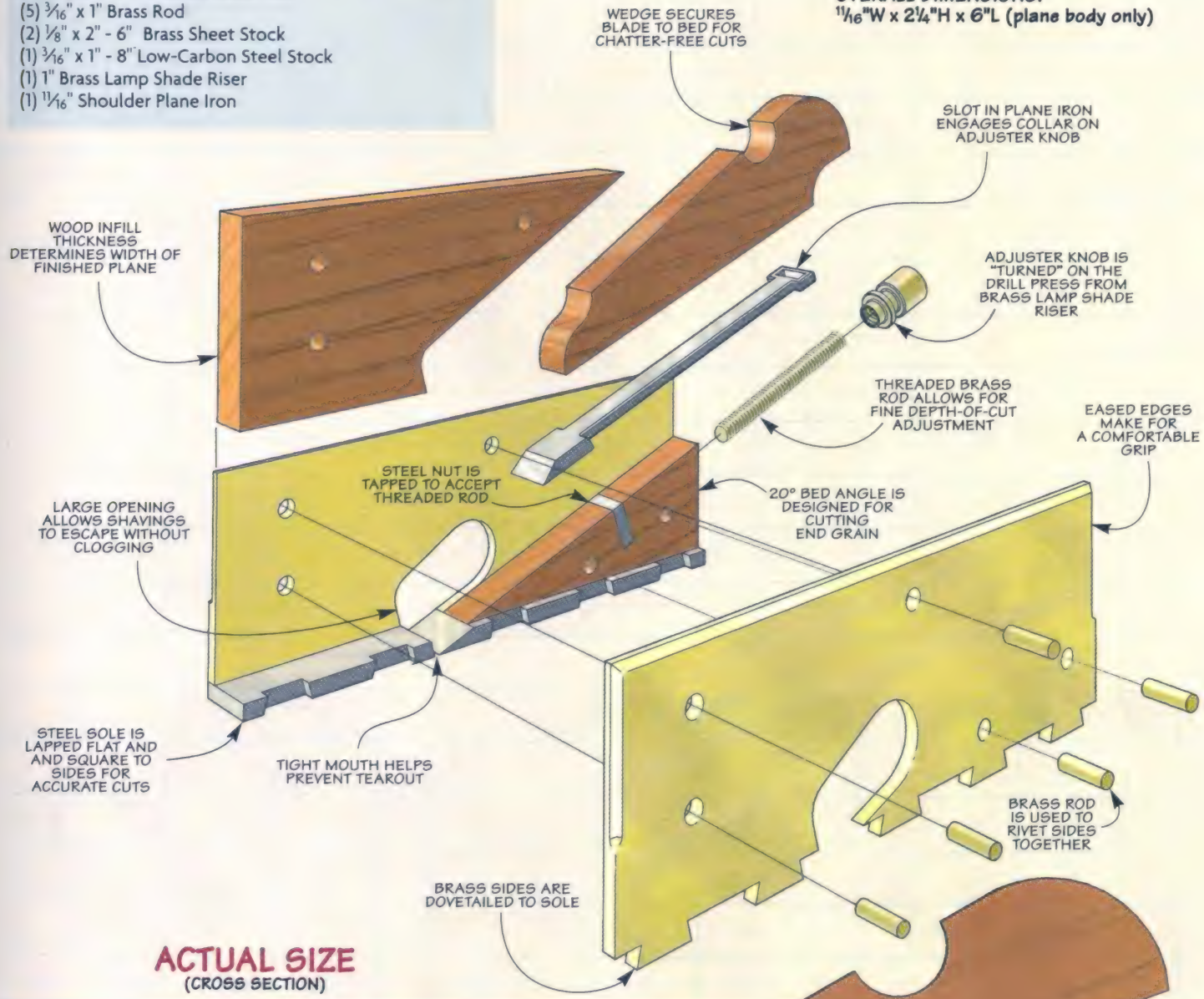
When building your own plane, you'll need to decide how to go about locking the iron (or blade) in place. I could have used a simple wedge to do this. But I wanted to be able to easily and accurately fine-tune the depth of cut. The solution is really pretty simple. I used just a few commonly available hardware items. This allows you to adjust this plane to make paper-thin shavings for tight-fitting joints.

Materials & Hardware

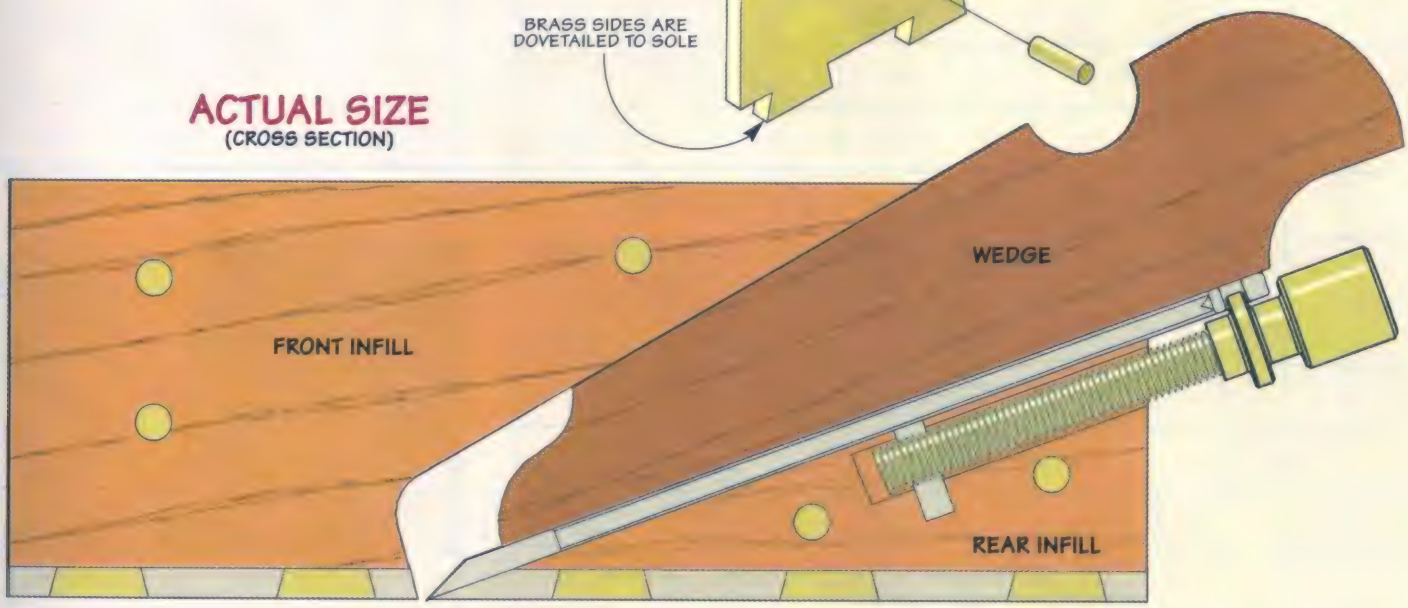
Infill and Wedge (cut from same piece) ½ x 4 - 8 (Rgh.)
(1) ¼"- 28 x 6" Threaded Brass Rod
(5) 3/16" x 1" Brass Rod
(2) ⅛" x 2" - 6" Brass Sheet Stock
(1) 3/16" x 1" - 8" Low-Carbon Steel Stock
(1) 1" Brass Lamp Shade Riser
(1) 11/16" Shoulder Plane Iron

Exploded View Details

OVERALL DIMENSIONS:
11/16"W x 2¼"H x 6"L (plane body only)



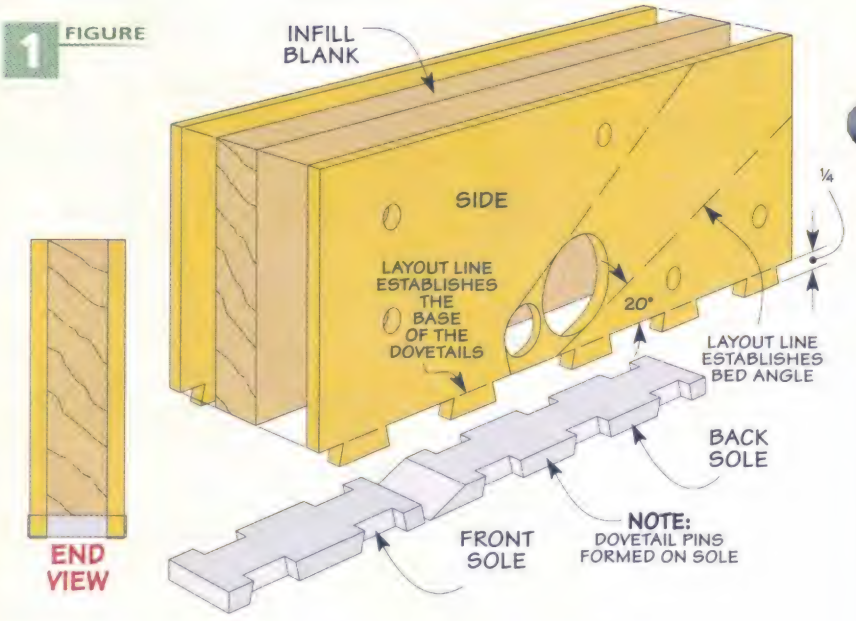
ACTUAL SIZE
(CROSS SECTION)



building the

Plane Body

FIGURE 1



The shoulder plane is made from a pair of brass sides and two steel sole pieces that wrap around the wood infill pieces and wedge. You can see what I'm talking about in Figure 1.

The box below shows the step-by-step process to layout and cut the dovetails. But there a few other things I want to mention.

Making the Sides. The first thing to do is make the brass sides since all the other pieces are made to fit them. You can turn to page 40 for an overview of the tools and techniques for working with metal.

Since the sides are identical, you can file and drill both at the same time, as shown in the box below. Using carpet tape to fasten them together, make sure to align one long edge and one short edge of each blank flush with the other. Now you can begin to make accurate layout lines using layout dye and a sharp scribe.

Laying it Out. The first important layout line you'll need is the one to mark the bottom of the dovetails. I made this line ¼" from the bottom edge as you can see in Figure 1. Since the sole is 3/16" thick, that'll leave about 1/16" of brass to peen over later when you lock the sides to the two sole pieces.

The next step establishes a reference line for the bed angle (Figure 1). The purpose of the bed is to provide support for the plane iron when it's wedged in place.

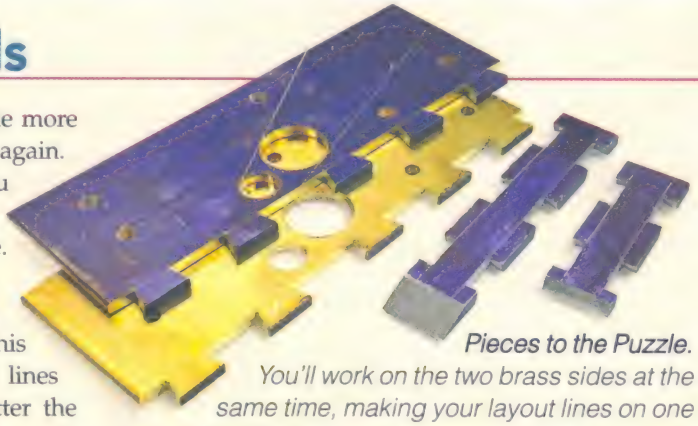
Step-by-Step: Filing Dovetails

Filing the double dovetails isn't as hard as you might think. It'll take some time and patience to get everything to fit right, though. They start out like ordinary dovetails. But later on you'll turn them into double dovetails. Here is what you need to know to get started and get great-looking double dovetail joints.

Clean Layout Lines. Just like you do in woodworking, you'll be "working to a line." This means you'll need sharp layout lines for the best results. Layout dye and a sharp scribe make it easy to mark your lines in one pass (Step 1). This will guarantee a thin, precise line you can work to while filing.

Use Guide Blocks. When you're filing, the file can skate across the metal, especially as you start the cut. To help guide my file, I clamp some scrap wood blocks along my layout lines (Step 2). And if you do happen to accidentally remove a layout line, just daub a little more layout fluid on and scribe it again.

Take Your Time. As you file closer to your layout line, take a little more care. And you might want to switch to a finer file. The more time you take at this point to get nice, straight lines and sharp corners, the better the dovetail joints will look in the end.



Pieces to the Puzzle. *You'll work on the two brass sides at the same time, making your layout lines on one side. The two steel sole pieces form the mouth.*

1 *Use a protractor and scribe to lay out the tails on the brass sides. I used an angle of 15° for looks and strength.*

2 *A square file quickly removes most of the waste. Then finish up the dovetails with triangular and needle files (inset).*

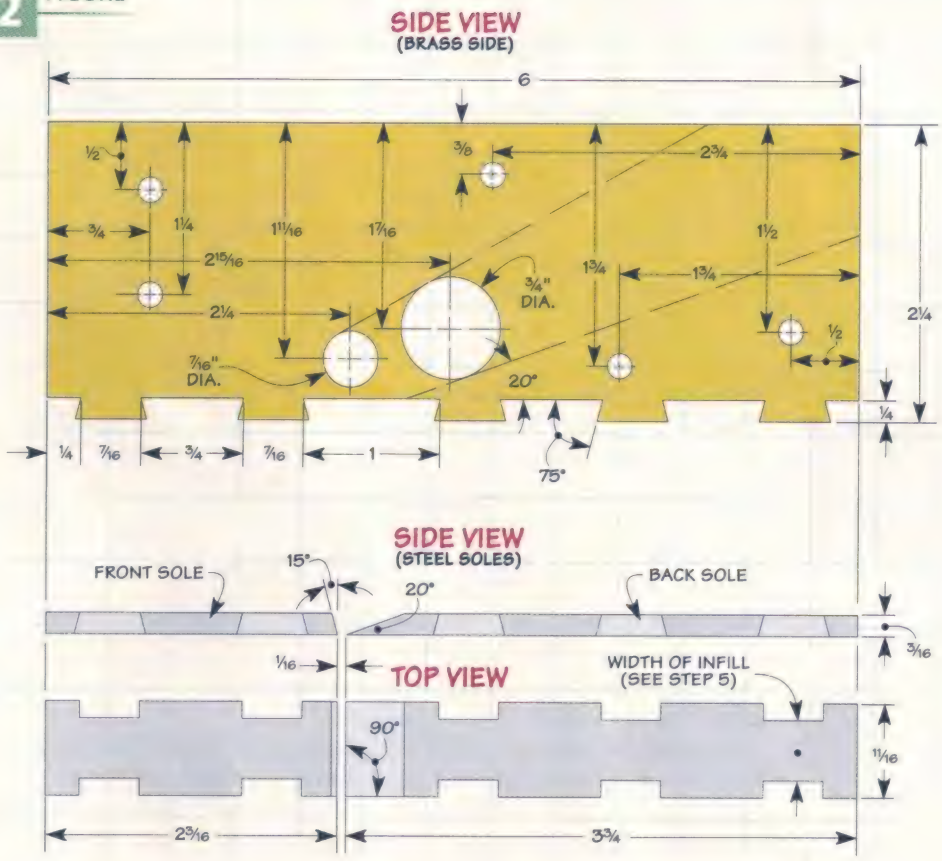
You'll use the layout line when you position the sole piece on the brass sides. The bed angle on the sole should line up with this layout line.

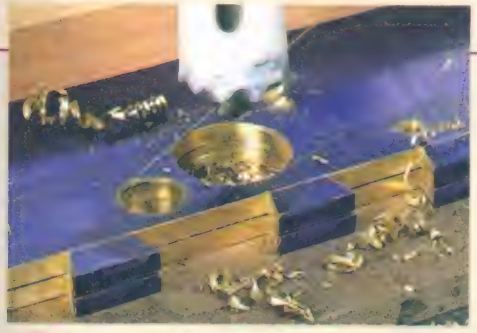
Tight, Square Mouth. There's one thing to point out when it comes time to cut and assemble the two blanks for the sole. To take a nice, clean shaving from end grain, the mouth opening needs to be pretty narrow. I shoot for about 1/16" (or a bit less) for the mouth (Fig. 2). If it's too narrow, you can always open it up as I'll show you later.

Infill Blank. Before making the sole, I chose a nice piece of hardwood for the infill. (I used padauk.) Step 4 below shows you how to use your plane iron to determine the final thickness of the infill.

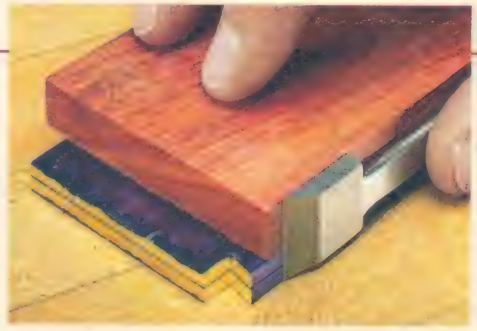
Filing for Tight Joints. With the layout lines in place and the infill blank in hand, you can follow the steps below to complete the sides and make the two sole pieces. I found it helpful to stop filing occasionally and test-fit the pieces until I got a nice, tight fit between them.

FIGURE 2





3 *I used a 3/4"-dia. hole saw and 7/16"-dia. bit to rough out the mouth opening. Then drill 3/16"-dia. holes for the rivets.*



4 *Using the plane iron as a gauge, plane the infill stock down until the plane sides and infill match the width of the iron.*

5 *After centering the infill blank on the sole piece, you can scribe the baselines for the dovetails.*

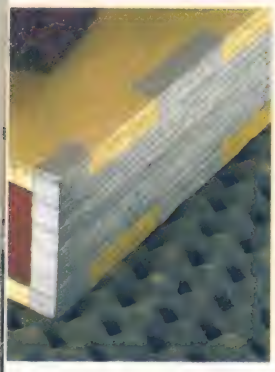
6 *Use a wood guide, cut to match the bed angle, to file the 20° bevel on one end of the long sole blank.*

7 *With a spacer block, hold the two sole blanks between the sides. Then scribe the pin profile on the sole blanks.*

8 *Once you rough out the waste to form the pins (like you did on the tails), finish up with fine needle files for a tight fit.*

assembling the

Body & Infill



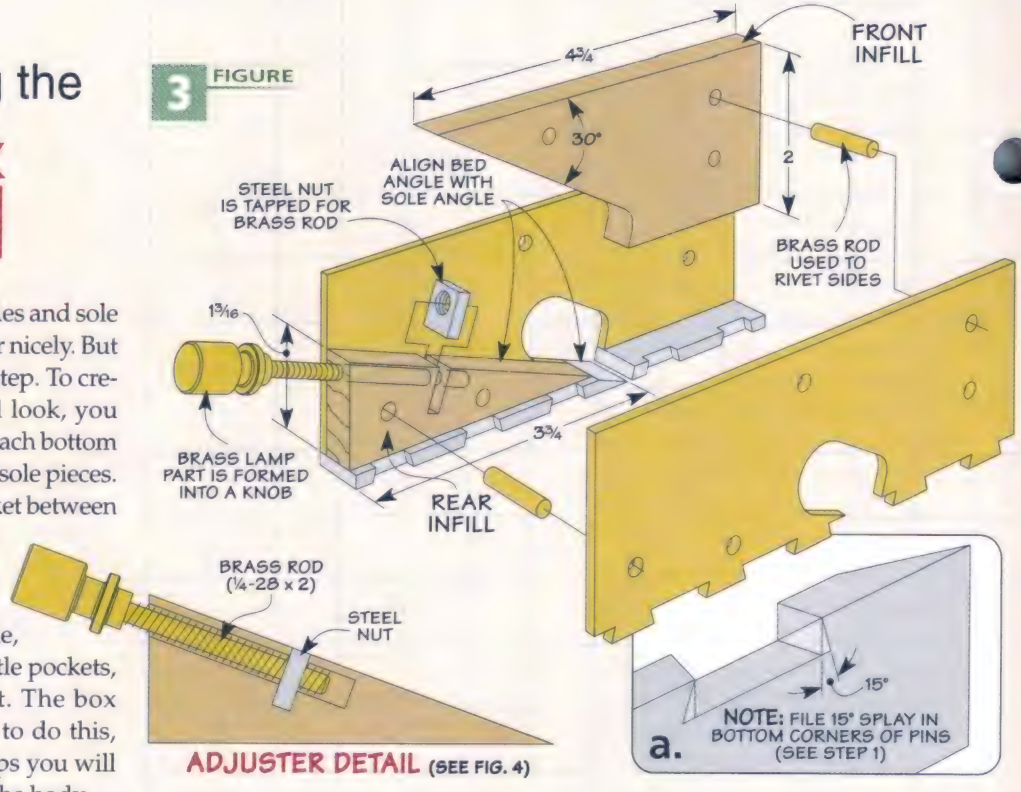
▲ *Double Dovetails. The simple trick to getting great-looking double dovetails is some careful filing.*

At this point, the two sides and sole pieces should fit together nicely. But there's one more small step. To create the double dovetail look, you need to file a "splay" in each bottom corner of the pins on the sole pieces. This leaves a gap or pocket between the pins and the tails on the sides (detail 'a'). Then, when you peen the brass sides to the sole, the brass fills in these little pockets, creating a locked joint. The box below shows you how to do this, along with the other steps you will need to do to complete the body.

Adjuster. Now that you have the "shell" of the plane done, you can move on to the infill and adjuster mechanism. The adjuster is made from three pieces. There's a knob, a short length of threaded brass rod, and a shop-made, steel nut.

The knob is made from a lamp part called a lamp shade riser (margin photo on opposite page). One end has a threaded hole that you'll use for the threaded brass rod. The other end has a stud that you can cut off. The top photo on the next page shows how I shaped

FIGURE 3

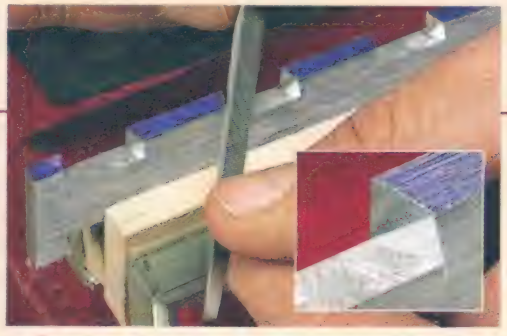


ADJUSTER DETAIL (SEE FIG. 4)

Step-by Step: Peening

Peening the brass tails into the steel sole pins is what holds the plane body together. You actually "flow" the brass into the joints. The trick to making the double dovetail, though, is in filing the "splays" in the sole pieces, as shown in Step 1. All you're doing here is removing a small triangular section of material from the bottom corner of the pin.

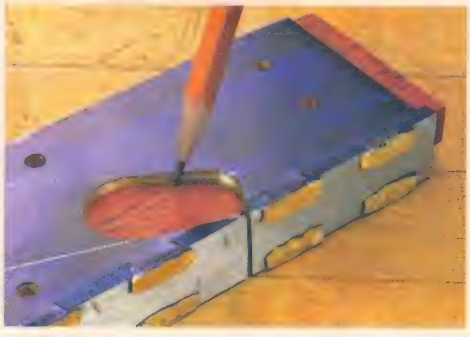
Peening Tips. Once that's done, it's time to peen the pieces together. There are some tricks to getting the best results. One is to have a solid surface to work on. I ended up using the peening buck (next page) on the concrete floor in my shop. Another trick is to make carefully directed hammer blows. It doesn't take a lot of force to move the brass into the joints. It'll look like a mess, but don't worry. You can take care of that when you file it smooth.



1 *A triangular file is used to create the 15° "pockets" on the sole pins. This will make them look like tails after peening.*

3 *Use files to finish forming the mouth to its final shape. But don't file below the layout line for the bed angle.*

2 *The object is to force the brass into the gaps in the sole. Work on a solid surface and take your time.*



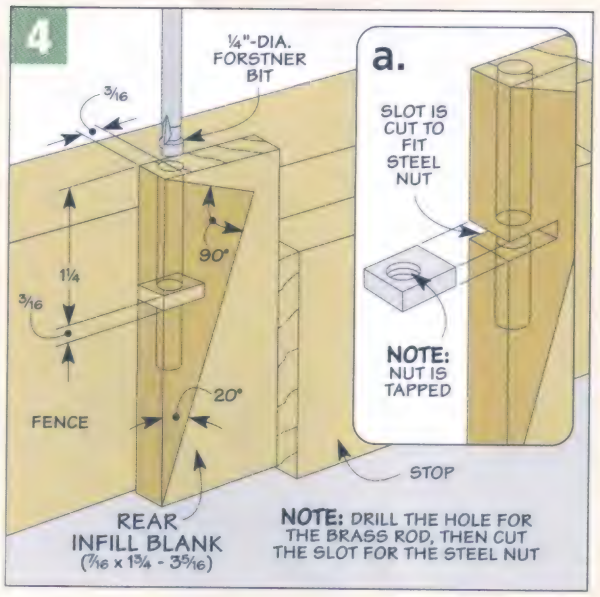
4 *Mark and cut the infill pieces and drill the rivet holes. The rear infill should line up with the bed angle on the sole.*

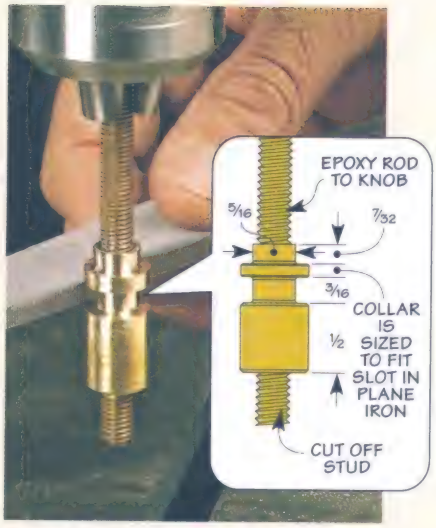
the knob on the drill press. The important thing is for the "collar" on the knob to fit into the adjustment slot on the plane iron. For fine adjustments, it should have a close fit without being too loose.

The shaft is a short length of ¼"-28 threaded brass rod. The knob is threaded onto one end and the other end of the rod engages a shop-made steel nut in the infill. The drawing on the previous page shows how it goes together.

I made the nut for the adjuster from a piece of leftover steel I used for the sole. It's drilled and tapped with a ¼"-28 thread.

Rear Infill. The rear infill is a triangular piece that houses the adjuster and forms the bed for the plane iron. You need to drill a hole for the adjustment rod and cut a slot for the nut. I found it was easier to do all this before cutting the infill piece to shape (Figure 4). After that, you can cut the 20° bed angle to match the sole and insert the infill into the body. Just make sure it lines up with the bed angle on the sole. Then you can trim the end flush with the brass sides.





▲ *"Turning" the Knob.* Chuck the knob into the drill press and use files to shape it. The collar should fit the slot in the plane iron.

Front Infill. The front infill is angled to match the shape of the wedge and hold it in place. (You'll make the wedge later). I roughed out the shape of the infill piece but didn't do any final work until I had the mouth of the plane complete, as detailed in the box below.

Rivets. The final step is to add the rivets that lock the sides and infill in place. I used a dab of epoxy to hold the infill pieces in place then drilled the rivet holes. After peening the rivets in place, they can be filed flush with the sides.

▲ *Shade Riser.* A brass lamp part is "turned" into the adjuster knob.

5 *Scrap laminate with holes allows the rivets to "mushroom" on the bottom. Remove it when peening the other side.*

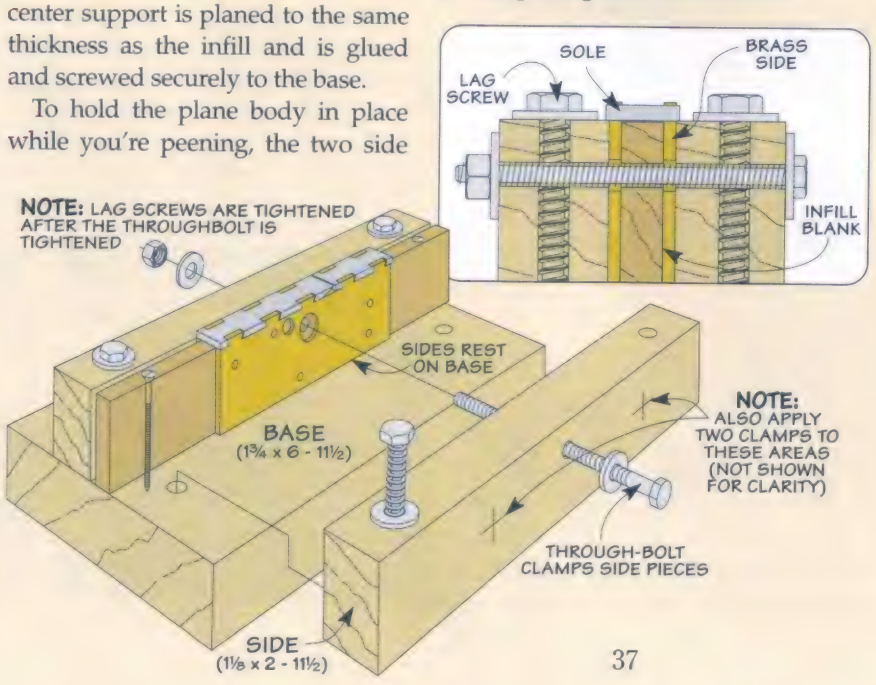
6 *A flat file smooths the sides and sole. Just be careful not to round over the edges of the plane body.*

Peening Buck

When peening the sides to the sole, I had trouble with the pieces shifting. So I came up with this "peening buck" to help hold the pieces securely.

The base and two side pieces are made from 1½"-thick hardwood. The center support is planed to the same thickness as the infill and is glued and screwed securely to the base.

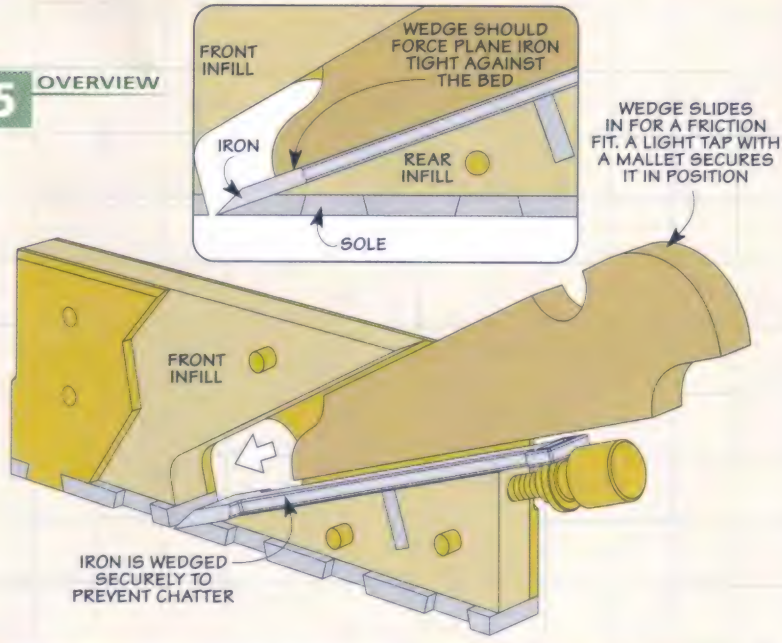
To hold the plane body in place while you're peening, the two side pieces have oversized holes for a pair of lag screws. A bolt clamps the side pieces of the plane tight. Then you can tighten the lag screws down. Finally, place the assembly on a firm surface and start peening using firm, direct blows.



adding the final

Details

5 OVERVIEW

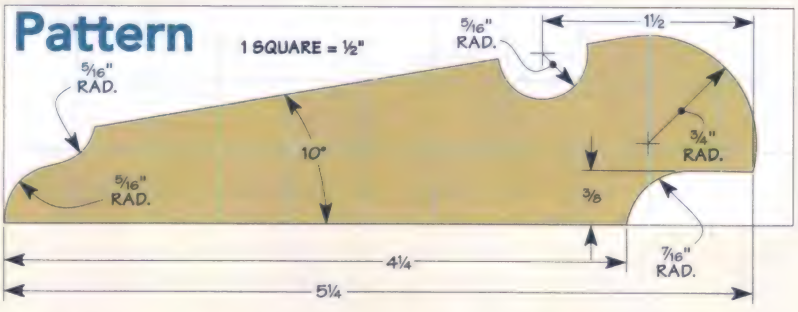


Now that you've got the body of the plane assembled, you can make the wedge and add a few last details.

Wedge. The wedge holds the plane iron securely in the plane. I made mine from the same stock as the infill. But you could use a different or contrasting hardwood for a "custom" look.

What's important is to shape the wedge so that it forces the plane iron tight against the bed, especially at the mouth. So some careful fitting is in order here.

You can use the drawings at right to rough out the shape of the wedge. Then it's just a matter of fine-tuning the fit as you go. The goal here is that the "nose" of the wedge should end up just slightly behind the bevel on the plane iron (see photo below). If the wedge is too tight to move that far forward, you can remove a little material at a time from the bottom edge, checking the fit as you work. Then you can sand the finger notches smooth and ease the edges.



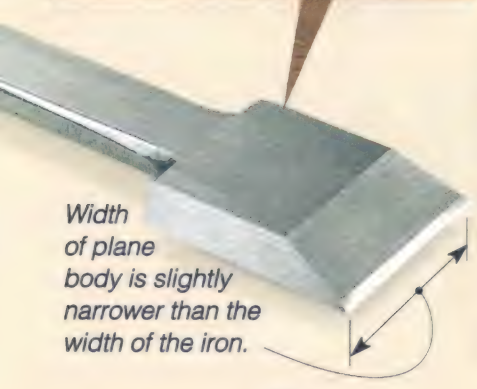
Tuning. At this point your plane is almost functional. But there are a few details to take care of before giving it a workout (see box below). For starters, you need to fine-tune the width of the plane body so that the iron projects a little from each side. This lets the plane remove shavings all the way into the corner of a joint.

Tuning Your Shoulder Plane

Now is the time to double check the width of the sole against the plane iron. You can use fine-cutting flat files and sandpaper to lap the sides of the plane to a smooth finish. The goal, besides a great appearance, is to have the edges of the plane iron projecting past the sides of the plane body just a hair. This helps the plane cut right into corners.

At the same time, you want to lap the sides and sole so they're square. Put some adhesive-backed sandpaper on your table saw and run the plane along the rip fence to keep the sides square with the sole.

Finally, check that the mouth is square to the sides and the bed is flat. The iron should sit tight against the bed without any gaps.



Fine-tuning the mouth opening.

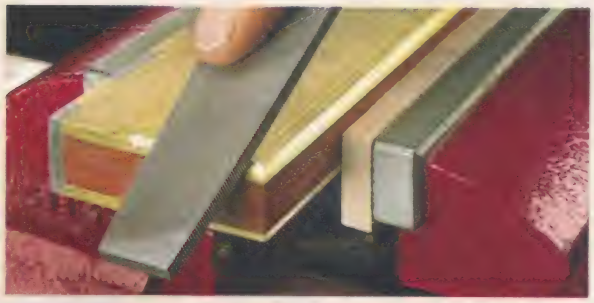
Lapping the sole flat.

Lapping while using the rip fence as a guide.

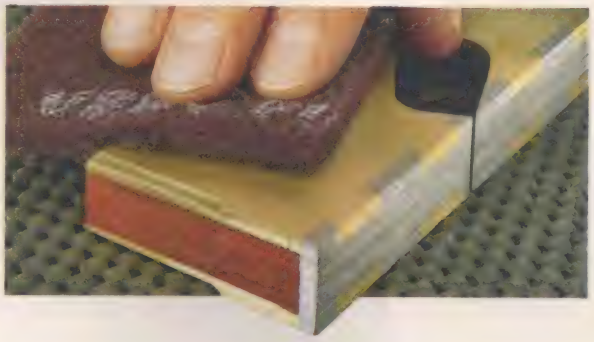
Chamfer and Polish. Traditional shoulder planes had a small chamfer on the edges. Besides adding a nice detail, it makes the plane more comfortable to use. A file makes quick work of adding the chamfers (upper right photo).

To finish up, I used some abrasive pads to polish the brass (lower right photo). A little oil gives a nice finish on the infill and wedge.

Once you've done this, you're ready to give the plane a try. The box below shows how to use your shoulder plane. After taking some time to get it set up just right, you'll be amazed at the results.



◀ ***Stopped Chamfers.*** *Use a flat file to form the chamfers on the edges of the plane.*



◀ ***Final Polish.*** *Use abrasive pads and wet/dry sandpaper to give the plane a polished look.*

Using the Plane

Shoulder planes get their name from their ability to slice the end grain on a tenon shoulder (Figure 1). They're designed for fine-tuning joinery. Since the plane iron is a hair wider than the plane, it can get "into a corner" for professional results.

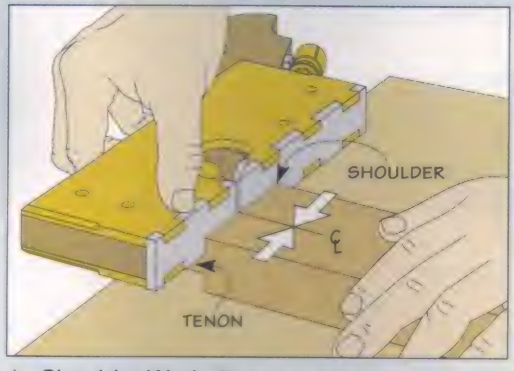
Tenons. When I want a perfect fit with mortise and tenon joinery, a shoulder plane can't be beat. I use it all the time to trim the cheeks of a tenon to get a snug fit in the mortise. And a couple of cuts on the tenon shoulders gives me nice, tight-fitting joints.

Rabbets and Dadoes. As you can see in Figures 2 and 3, a shoulder plane is also ideal for fine-tuning rabbets and dadoes. You can fine-tune the thickness of a rabbet by sneaking up on the fit. And it works just as well for cleaning up the shoulder.

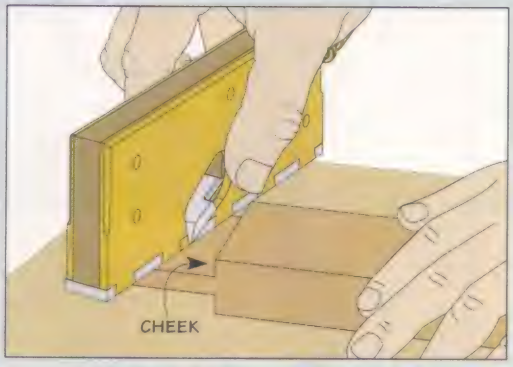
A dado blade is a great way to cut grooves and dadoes. But there's a problem. The bottom of a dado or groove can be rough. But a shoulder plane makes it easy to clean up the bottom of the dado.

Since the shoulder plane excels at working into corners, it works great on lap joints, too.

1. Tenons

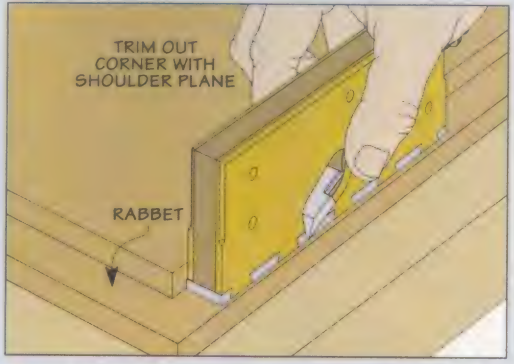


▲ ***Shoulder Work.*** *The shoulder plane excels at slicing the end grain of a tenon shoulder. For best results and to prevent tearout, work from both sides toward the center.*



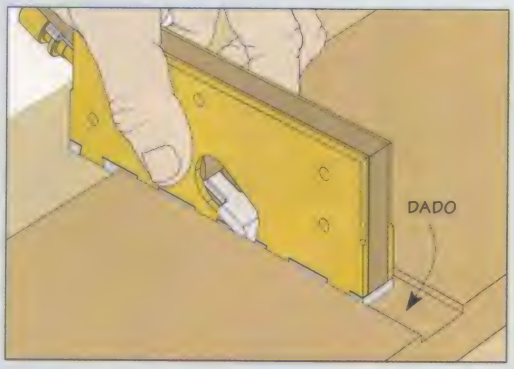
▲ ***Smooth Cheeks.*** *Remove saw marks and sneak up on a snug fit using the shoulder plane. Shave equal amounts from both cheeks to keep the tenon centered on the workpiece.*

2. Rabbets



▲ ***Width and Depth.*** *Clean up the face of a rabbet and fine-tune the depth using the shoulder plane as shown. Flip it on its side to dress up the shoulder of the rabbet.*

3. Dadoes & Grooves



▲ ***Clean Bottoms.*** *A pass or two with a shoulder plane is all it takes to get rid of saw marks and create a smooth bottom in dadoes, grooves, and lap joints.*

tips and tools

Metalworking Techniques

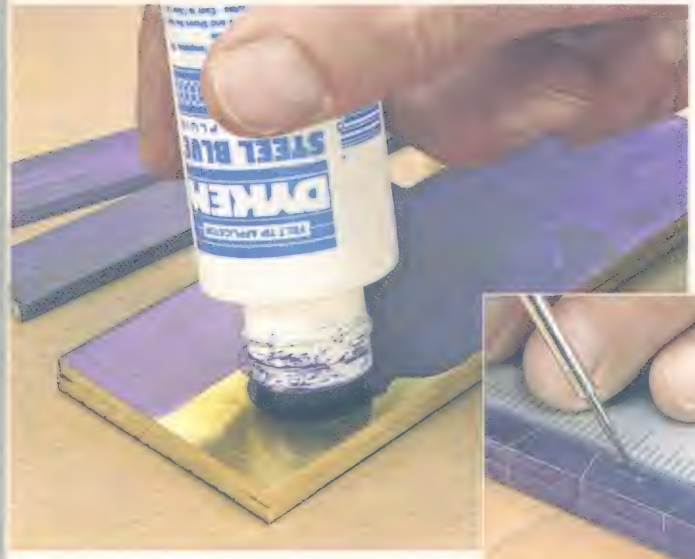
Put your shop skills to use on brass or steel — you'll be amazed at the results.

As a woodworker, I've always felt a little bit intimidated when it comes to working with metal. But building the shoulder plane on page 32 taught me that many of the tools and skills necessary for working metal are similar to those I already use in the woodshop.

In fact, there are a couple of things I prefer about working with metal. First, it's far less sensitive than wood to seasonal temperature or humidity changes.

Second, metal usually comes with flat reference edges. That means you can start laying out and working without taking any of the steps you'd need to make wood flat and square. You just need to clean off the protective oil coating.

But more than anything, I like the results. The combination of brass, steel, and hardwood gives the plane the professional look and feel of an heirloom-quality tool.



◀ *Using Layout Fluid. Coating the surface of the metal makes scribed marks easier to see.*

Once you've learned a few simple metalworking techniques, you'll be up and running. But before you begin it's important to pick the right materials.

Types of Metal. Brass, copper, and aluminum are great choices for woodworking projects. I like these metals not just because they're strong and decorative, but because they're soft enough to be cut and shaped with common, carbide-tipped woodworking tools.

That's not the case with low-carbon, or mild steel. It requires a little bit more effort to cut and shape. But it's a good choice when you need a material that will stand up to more abuse, like the sole of the shoulder plane.

LAYOUT TOOLS

Like woodworking, the first step in a metal project is the layout. But making layout lines on metal is a little different. Pencil marks wipe

away too easily and permanent markers leave too wide a line.

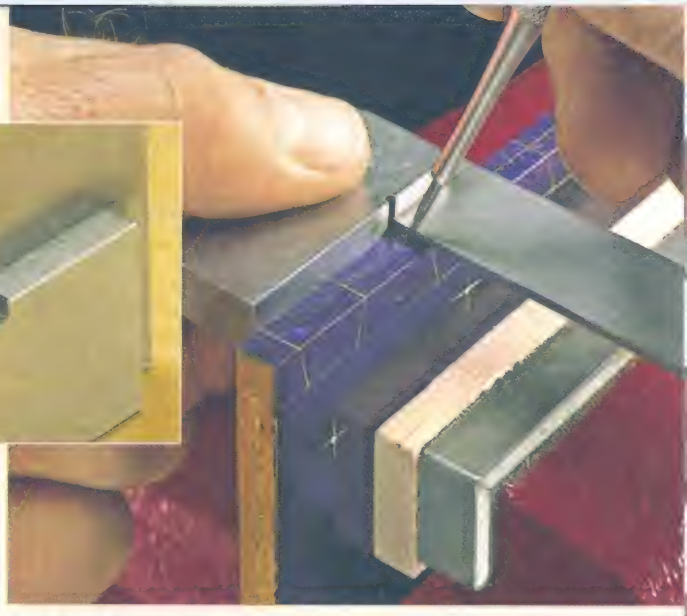
Scribes. The right tool for the job is a metal scribe. Scribes are available in a variety of styles, with either pointed or flat tips. You can buy carbide-tipped scribes, but the steel one in the photo below is less expensive and more than adequate for marking on brass or mild steel.

Using a scribe is just like using a pencil. You simply pull it along a straightedge to mark your layout line. A good scribe will lay down a thin line, similar to a woodworker's marking knife.

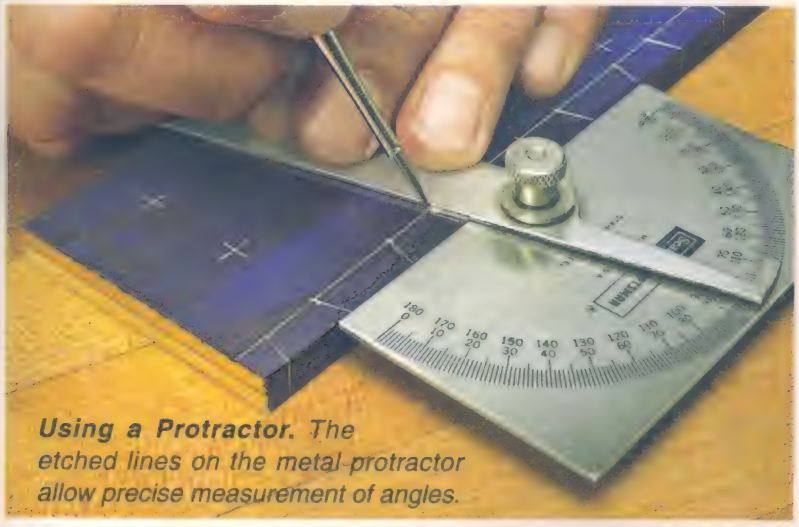
Layout Fluid. But even a scribed line can be hard to see. The solution is to coat the surface with layout fluid. This way, you'll be able to see your lines easily. The contrasting color of the layout fluid makes this line visible, even for the most exacting measurements.

Different colors of layout fluid are available in bottles with brushes or felt-tipped applicators, so covering the surface is just a matter of daubing it on and letting it dry. Then, you can mark your layout, as shown in the photo below. I use mineral spirits to remove the dried fluid when I've completed a project.

For marking a layout, you're probably already familiar with most of the tools. Machinist's squares, steel rules, and protractors are more accurate and less expensive than their rosewood-handled woodworking cousins.



▲ ***Machinist's Square.*** *These metal squares are durable and very accurate. The indent on the handle is used to align a scribe to a layout line.*



Using a Protractor. *The etched lines on the metal protractor allow precise measurement of angles.*

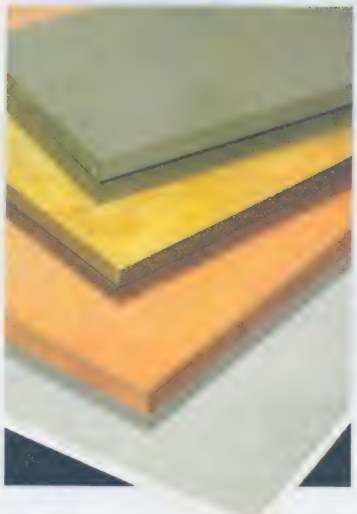
Squares. A good investment is to buy a set of different-sized machinist's squares, since they can serve double duty in your woodworking as well. You'll notice in the photos above that these squares have a small indentation where the handle meets the blade. This allows you to put the point of a scribe at the very edge of a piece and make a precise line.

Protractors. For laying out angles, such as the dovetails on the shoulder plane, you'll need a metal protractor. Again, this is a handy tool for the woodshop as well. They're inexpensive and very accurate. The model shown in the photo at left is easy to read, with etched markings on the protractor and an engraved line on the arm. It also has a knurled knob which locks in the desired angle.

Punches. Another marking tool to keep handy is a punch. It's the best way to mark a precise location for a hole. The type I like to use, shown at right, is spring loaded. With it, all you need to do is put the point on your layout line and press down until the spring triggers. The resulting dimple marks the point and also serves as a starter for a drill bit to prevent it from "walking" away from the mark.

▲ ***Metal Punch.*** *The spring-loaded punch is easy to use and leaves a handy dimple for starting a drill bit.*

Metals in the Woodshop: Options



For metal accents or components in your projects, aluminum, copper, brass, and mild steel are all good options. The flat brass stock I used for the shoulder plane is an alloy known as cartridge brass. It's hard enough for most applications, but still works very easily.

Mild steel is the next level of hardness, perfect for the plane sole. You'll see it for sale as low-carbon steel. Turn to page 51 for details and ordering information.

working with Metal

After you've completed the layout for your project, the next thing you'll need to do is cut the pieces to size. Here again, you're probably familiar with the tools you'll need, but you'll want to keep a few things in mind before you begin.

Safety First. It's a good idea to clean up the sawdust around your table saw and disconnect the dust collector from any tools you'll be using. You may not get many sparks, but brass shavings are very hot. They could smolder in a pile of dry sawdust, resulting in a fire.

The most important safety concern is eye injury. If you've gotten out of the habit, now is the time to dust off your safety glasses and make sure to wear them. They'll guard against flying metal shards.

The noise from cutting brass is more than an irritant — it's also a safety issue. So I always put on a pair of ear muffs before I cut metal with any power tools.

CUTTING AND SHAPING METAL

The easiest way to cut brass is at the table saw. A "non-ferrous," metal-cutting blade will slice through sheet brass very easily. In addition to triple-chip ground, carbide teeth, these blades are designed with a negative hook angle to prevent kickback.

Unfortunately, you can't cut low-carbon steel with your standard woodworking machines. So, when it comes to mild steel, I prefer the old-fashioned method — a hacksaw (inset photo at right). It's fast enough for small projects and a whole lot quieter too.

Cutting on Table Saw. *A non-ferrous blade can cut flat brass sections easily. (Blade guard removed for clarity.)*

Cutting with a Hack Saw. *Use a good-quality saw with a bimetal blade to cut pieces of mild steel.*

The key to getting the best results is to use a high-quality hacksaw with a bimetal blade. The nice thing is that neither one is expensive. A good saw will have a stiff spine and frame that won't twist or flex while you're cutting. That means you'll get a smoother cut. The hacksaw should also allow you to angle the blade for through cuts, as you can see in the inset photo above. You just need to position the stock in the side of your vise to make the cut.

Working with Files. When it's time to clean up a sawn edge or shape a part, you'll need a few different types and cuts of files. You may already have a few of these lying around in your shop, but if not, they aren't very expensive.

The files you'll need most often are the large, flat pattern files, like those shown on the opposite page.

▲ ***Thinking Safety.*** *The shavings and sharp edges created as you work make eye and ear protection a must. So always wear your safety glasses and ear muffs. In addition to installing the right saw blade, you'll want to make sure you have the guard in place at all times. And finally, a pair of leather gloves can provide added protection as you work.*

▲ ***Flat File.*** *When it comes to dressing edges and shaping metal, flat files work quickly.*

▲ ***Triangle File.*** *For shaping tight corners and angles, different sizes of triangular files work great.*

The coarse, bastard-cut file is the workhorse. You'll use it to smooth rough edges and saw marks or to rough out the shapes of dovetails.

Next, you can progress to the second-cut file. It's great for smoothing a cut and refining tighter shapes. Finally, the smooth-cut flat file is for finish work. With it, you can get a crisp edge and smooth surface for metal joints.

Shaping Files. You'll also need some smaller files for the more intricate finish work, like making the double-dovetails used to join the sides and bed of the shoulder plane. The most commonly used of these smaller files is the triangular, or "three-square," smooth-cut file.

For work in tight spaces, needle files are the answer. They come in a variety of shapes and sizes. They're especially useful for detail work.

Barrette files are shaped like a knife blade with a flat cutting face and smooth beveled face. This is helpful for getting into tight spots where you don't want to mar the opposite face. I used a fine barrette file to clean up the mouth of the shoulder plane. They're also available in different cuts, listed as 00 through 6. The finest cut, 00, is used for extremely fine jewelry work. For most metal working, I find files in the 2-4 range work well.

Joining Metal Parts. Unlike working with wood, you won't need glue and clamps to assemble your metal projects. The strength of these joints is usually mechanical, (although solder can be used to reinforce the joint). That's why careful shaping of interlocking pieces is so important. You don't want any gaps when joining metal. There is, however, a technique for closing gaps to secure a tight fit.

Peening, the process of hammering the mechanical joints of metal pieces together, expands metal and makes it "flow" into place. The tools required are a solid metal-working vise or anvil and a ball pein hammer, shown in the opening photo on page 40.

When you begin, it's helpful to keep in mind that metal is malleable. In other words, you can push and stretch the metal pieces together using carefully directed taps from the ball end of the hammer — don't pound the pieces like you would a nail.

Patience is the Key Technique. In the case of the shoulder plane, you'll be peening the brass dovetails into the steel sole. I found it easiest to work the angles back and forth, gradually learning to judge the amount of force necessary to coax the parts together.

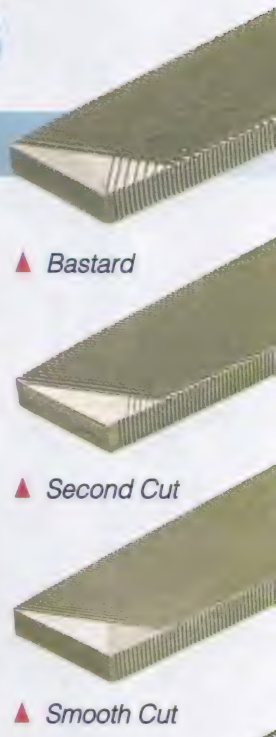
As similar as metalworking is to woodworking, it will still take you a while to get the hang of it. Once you give it a try though, you'll be surprised at how quickly you can start using these basic techniques to add some variety to your woodworking projects.

Shaping Metal: File Types

Flat Files

I prefer to use double-cut files (like those shown at right) for brass and mild steel. They have a second set of cutting ridges that runs diagonally to the first. I think of them like progressing through grits of sandpaper in a woodworking project.

Start with the coarse bastard cut. It will remove lots of metal in a hurry, so you'll need to be careful with brass. Progress to a second-cut file for smoothing and refining a shape. Finally, the smooth-cut file really excels at dressing edges and flat cutouts.



▲ *Bastard*

▲ *Second Cut*

▲ *Smooth Cut*

Shaping Files

Shaping files allow you to refine tight corners, curves, and other shapes. I find that the round and triangular profiles come in handy on just about every metal project. These profiles are available in different sizes and cuts, all the way down to the very small needle files.

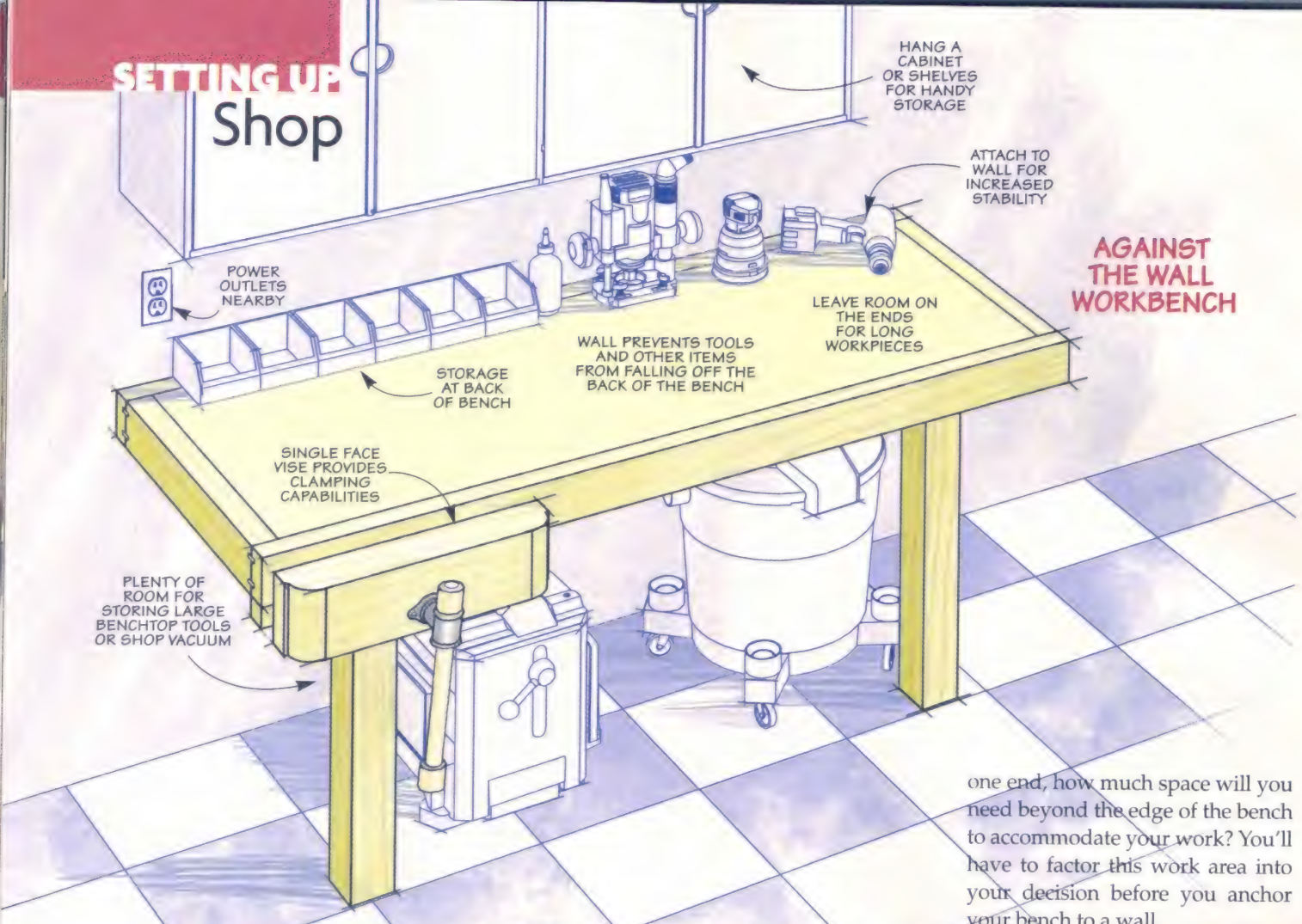
I like barrette files for work in tight spaces. They have a knife shape with cutting ridges on only one face to prevent scratching adjoining surfaces.

▲ *Triangular*

▲ *Round*

▲ *Barrette*

◀ ***Keep your Files Clean.*** *A file card is a necessity when shaping metal. Use it often to avoid loading up with fine metal filings.*



placing your Workbench

Workbenches come in all shapes and sizes — from traditional, maple-topped benches with tail and face vises, to a sheet of MDF on a two-by-four frame.

But for your bench to actually become a useful tool in your workshop, where you place it is as important as how it's built. Here are a few options and some things to keep in mind while you're setting up your shop.

AGAINST THE WALL

In a small garage or basement shop, floor space is always at a premium. Placing a bench against a wall, as shown above, leaves the middle of your shop free for the table saw, jointer, and other large stationary tools. I like this arrangement because it adds stability to the bench, especially if you anchor it to the wall. In many cases, you'll also have a power outlet nearby.

One big advantage to placing your bench against the wall is how easy it is to add a few shelves above it for handy storage. I like the convenience of having hand planes, bench chisels, and other frequently used tools within arm's reach.

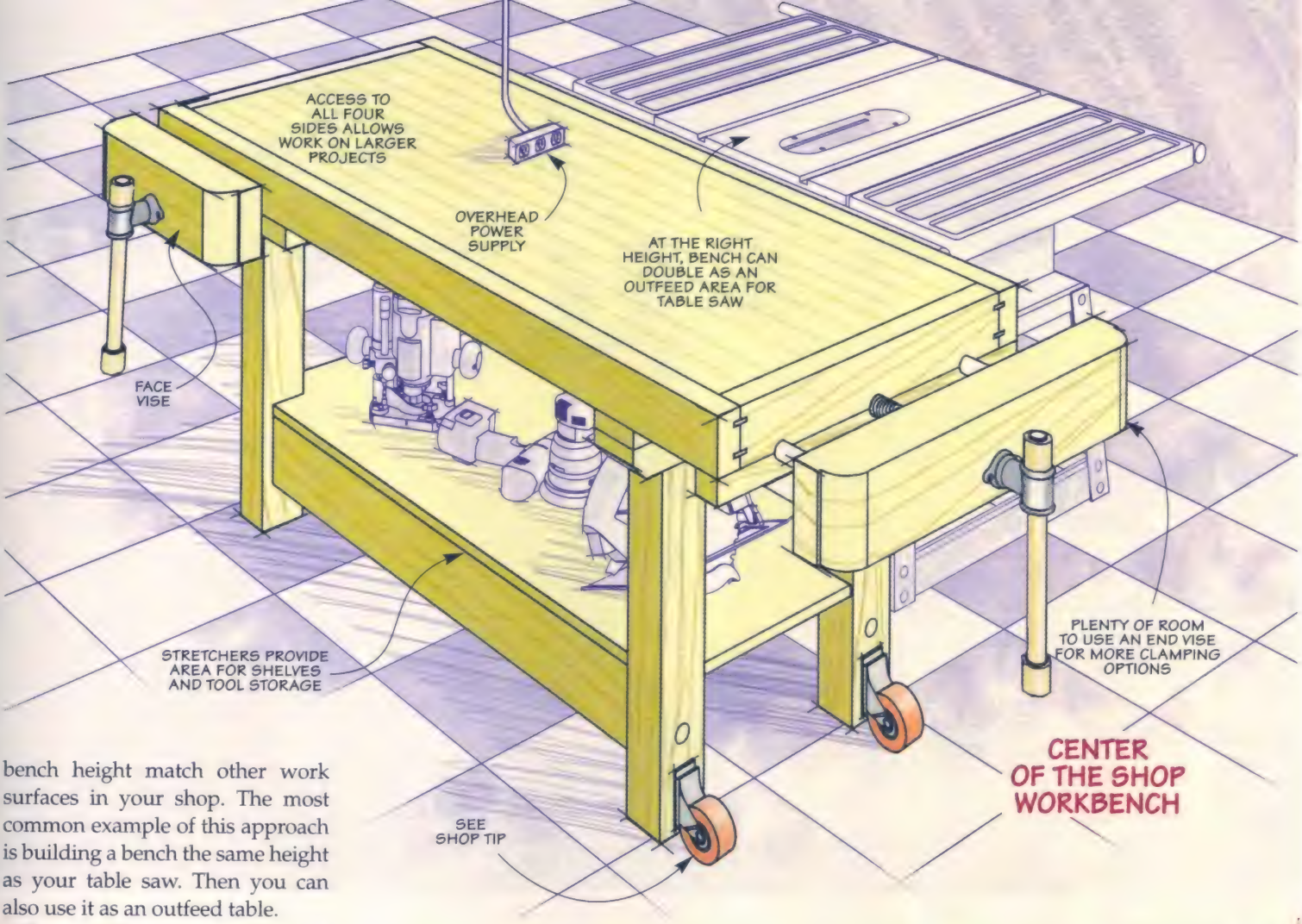
Work Area. One thing to keep in mind, however, is the actual work area your bench requires. That is, how much space on each end you'll need if you're working on a long board. If you have a vise on one end, how much space will you need beyond the edge of the bench to accommodate your work? You'll have to factor this work area into your decision before you anchor your bench to a wall.

The biggest disadvantage of a wall-mounted bench is that you only have access to three of the four sides. That not only restricts your movement around the bench, but it makes it much more difficult to work on a large project.

CENTER OF THE SHOP

Locating your bench nearer the center of the shop, like the illustration on the opposite page, allows you to work around all four sides. I like this position because it offers more room to work on larger projects. Another advantage is you'll be able to use the bench for assembly in different ways. For example, it's often useful to be able to clamp pieces directly to the benchtop. And by using cauls, you can apply downward pressure to an assembly. Like clamping a tabletop down onto a frame, for instance.

Although this arrangement takes up more space, you can minimize the impact by making your



bench height match other work surfaces in your shop. The most common example of this approach is building a bench the same height as your table saw. Then you can also use it as an outfeed table.

Power. One concern about having a bench away from the wall is power. You can make up for the lack of a wall outlet by running power down from the ceiling (maybe you have a garage door opener outlet there). Or you can mount an extension cord on hooks to hang down near the bench.

For storage, instead of the wall-mounted shelves you can always add a few drawers or cabinets in the base of your bench. Then you'll be able to keep your hand tools where you need them.

The Best of Both Worlds. Of course, there are always alternatives. Like any other shop tool, you can make your workbench mobile. The box at right will give you a practical idea for this.

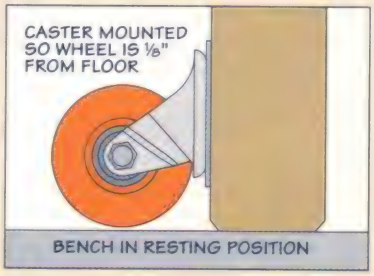
Small shops force us to think creatively to be able to get the most out of the space available. A good decision where to place your workbench will help you get more out of your time in the shop.

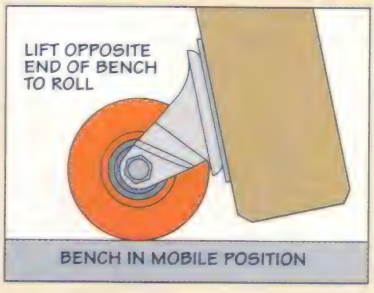
Rolling Workbench

Adding wheels to your bench allows you to position it wherever you need it for a specific project. But simply adding casters sacrifices stability. Even locking casters can wobble if you're pushing hard on workpiece, such as planing a long board.

One solution is to mount the casters so they're off the floor when they're not being used. I fasten them on only one end of the bench, as shown in the illustrations at right. This way you have all four legs on the floor, providing a stable platform. But when you need to move the bench, you just pick up the opposite end and roll it into position.

The key is to mount the wheels at the correct height. I've found that a ⅛" gap is perfect. At that height, you only need to lift the end of your bench a few inches off the ground to engage the wheels and roll your bench into place.





SHOP TIP

◀ *The Right Casters. A good quality, non-swivel, 3" caster works great for adding mobility to your bench.*

Smooth curves in just minutes. This simple technique is one you'll want to try.

Kerf Bending Plywood

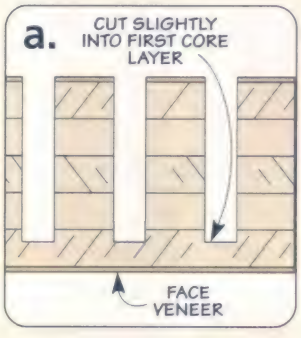
When you include plywood in a project, it's often because you can count on it staying flat and straight. But hardwood plywood is also a great material for adding smooth curves to a project. The photo above shows an example of this *and* how it works. The key is a simple table saw technique called kerf bending.

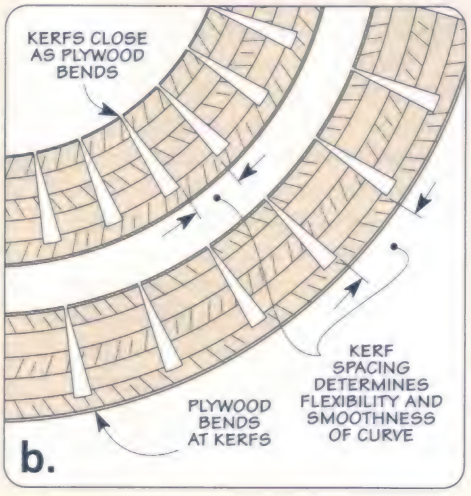
How It Works. Kerf bending involves cutting a series of evenly spaced kerfs along the length of a workpiece that run perpendicular to the grain. The kerfs extend most of the way through the thickness leaving only a thin web of wood bridging the kerf. This web of wood is flexible enough to allow the workpiece to bend at the kerf. So you end up creating a series of small bends (and flats) that blend into a smooth, even curve.

The distance between the kerfs (and their depth) determines the flexibility of the workpiece and the smoothness of the bend (detail 'b' and left margin photos). The closer the spacing, the tighter the bend you can make. And when glued to a form (or glue blocks) you end up with a smooth, solid curve.

Why Plywood? Kerf bending works with solid wood, but hardwood plywood is always my first choice. Detail 'a' at left illustrates why. When I kerf plywood, the cuts extend just into the "crossgrain" veneer layer below the thin, hardwood face veneer. The long grain face veneer bends easily but also serves to hold the "kerfed" layers together. The remaining core veneer reinforces the face veneer but likewise, has enough "give" to make the piece flexible.

The Basics. One of the big pluses of kerf bending is that it's easy to do the job on the table saw. Basically, you just have three





◀ *No Visible Flats. In the upper example, the bend is too tight for the kerf spacing. Not so, below.*

simple things to get right. First, you need to cut the kerfs to the correct depth. This is what makes the workpiece flex easily.

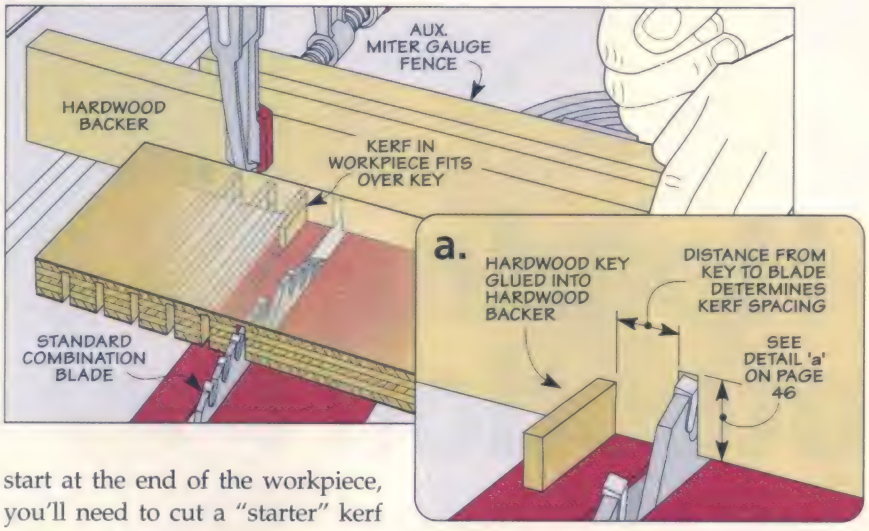
Second, you want to space the kerfs so that the workpiece conforms to the desired curve without showing flats and ridges. This depends on the shape of the curve.

Finally, the distance between the kerfs should be consistent. If not, the bend can turn out "lumpy."

A Simple Jig. The drawing at right shows the setup I use to get everything right. It starts with a standard combination blade. But at the heart is a kerfing jig clamped to the auxiliary fence on the miter gauge. This simple jig consists of a long, hardwood backer piece with a single, shallow kerf cut into it. A hardwood indexing key is glued into the kerf to allow you to quickly and accurately cut a series of evenly spaced kerfs.

Getting Adjusted. Once you've sized the workpiece and decided on the kerf spacing, it only takes a minute to get set up. First, adjust the height of the saw blade — a test cut or two will help with this.

Next, you need to position the kerfing jig. (Note: If the kerfs don't start at the end of the workpiece, you'll need to cut a "starter" kerf before adding the jig.) Start by sliding the miter gauge and the jig up to the blade. Then measure between the blade and key to set the spacing you want. Clamp the jig down and you're ready to go.



Cutting the Kerfs. Other than being pretty repetitive, cutting the kerfs is easy. After the first cut, lift the workpiece, move it over and position it over the key for the next cut. You simply repeat the process as many times as necessary.

But there are a few things to keep in mind. The quality of the cuts isn't real important. So I save time by carefully pulling the workpiece back across the blade before repositioning it. And before making the next cut, be certain the workpiece is firmly positioned over the key and flat on the table. And finally, it's easy to hurry and not complete a cut before pulling the workpiece back and starting the next one. I just try to be patient.

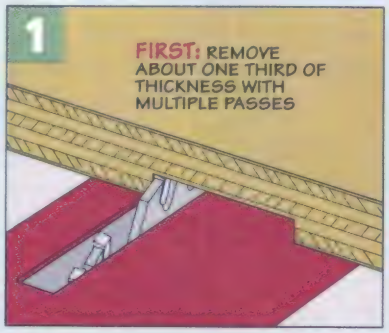
Kerf bending plywood may not be a technique you'll use often. But once you give it a try, I bet you'll find yourself thinking about ways to use it on a project. And for a slight twist on this technique, check out the box below.

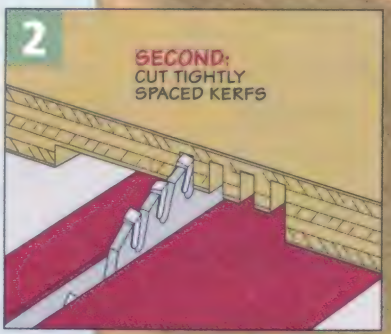
Extreme: Kerf Bending

As you can see in the photo at right, kerf bending plywood isn't limited to gentle curves. With a slightly different technique you can make plywood bend around a corner. The example shown has a radius of 1¾" and even tighter bends are possible.

For these extreme bends, you need to change a couple things. First, the kerfs are very tightly spaced — only ⅛" between them. And I cut the kerfs a hair deeper.

Some Relief. But even with this tight spacing, as you bend the workpiece, the kerfs will pinch closed and prevent a tight curve. The solution for this is simple. Before cutting the kerfs, you remove this interference by creating a shallow notch, the width of the bend, as shown in Figure 1. Then kerfs are cut from side to side using the jig (Figure 2). The workpiece will now bend easily and a glue block will maintain the shape.





A Rounded Corner. *Tight kerf spacing along with a notch on the back side make extreme bends possible.*

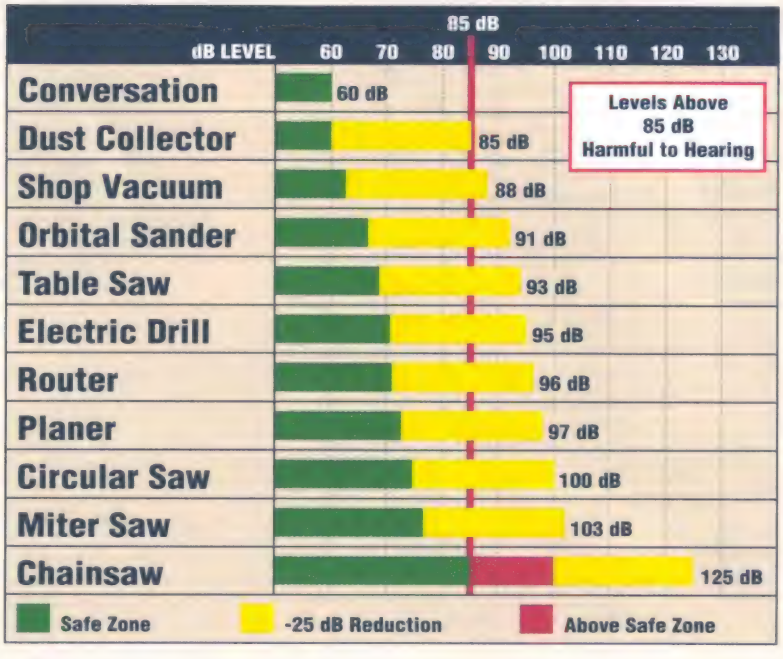
getting the best Hearing Protection

One of the keys to healthy hearing is to reduce tool noise to a safe level.

Every woodworker is aware of the danger of a spinning saw blade. But the potential harm from shop noise isn't always quite so obvious. These sounds can damage your hearing bit by bit over time. In fact, you may not even know it until it's too late.

Harmful Range. The problem is the loudness of sound, which is measured in decibels (dB). Most experts agree that exposure to noise of more than 85 decibels can be harmful to your hearing. And the longer the exposure, the more damage that's done.

As shown in the chart below, most power tools operate at or above this harmful level. That's why it's always important to wear hearing protection when using these tools.



TYPES OF PROTECTION

You'll find most hearing protectors decrease the amount of sound that reach the ear drum an average of 25 decibels. This brings the noise made by most power tools down to a level that's safe, as the chart at left shows.

Ear Plugs. The most generic device is a set of ear plugs like the ones shown at the top of the opposite page. They're inexpensive and easy to use.

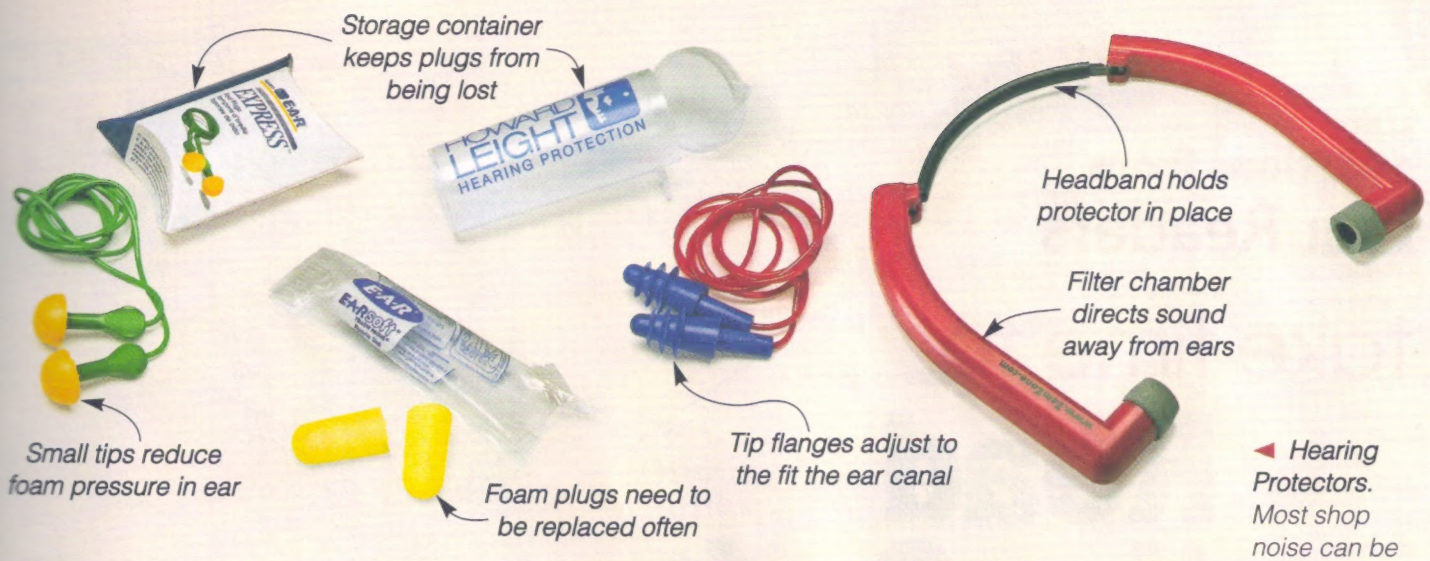
These small plugs fit in the ear and block the entire ear canal. Since they come in a variety of shapes and sizes, be sure to try out a few types until you find one that's comfortable enough to use all the time.

The most basic of these is the disposable foam plug. You simply roll the foam between your fingers and then place it in the ear canal and let the foam expand. I find it's often challenging to get them squeezed down small enough to get into my ear. And if they don't fit in the ear canal snugly they may not block the sound adequately or they simply fall out. Plus, you'll find you can only use these a few times before they need to be replaced.

A variation of the foam ear plug has a small foam tip attached to a plastic stem. You'll find these easier to insert into your ear. And the small foam tips don't create as much pressure in the ear canal. Both plugs are often connected to a plastic cord that hangs around your neck. This makes it easier to take them out of your ears without losing them.

Another type uses a soft plastic plug to block the ear canal. It has flanges at the tapered tip that allow them to adjust to fit the size of your ear. I sometimes find it hard to get these in my ear. But once in place, they're a lot more comfortable to wear for long periods of time.

ZEM Protector. If you find having something stuffed in your ear to be uncomfortable, there's another



◀ *Hearing Protectors. Most shop noise can be reduced to a safe level by using simple protective devices.*

device called the ZEM you might want to try. It works a little differently. Instead of blocking the ear canal, a filter chamber contains material that directs the sound away from the ear (photo upper right).

Ear Muffs. The hearing protector I find most comfortable to wear is a muff-type unit, like those shown in the photo on the previous page. They fit over the entire outer ear to form an air seal that blocks sounds from entering the ear. An adjustable band lets you customize the fit.

The only problem with muff-type protectors is if you have long hair, wear eyeglasses, or use safety glasses it may be difficult to get the ear piece to seal properly around your ear. This can cause you to lose some degree of protection.

High-tech electronic muffs are also available. You can learn more about them in the box below.

Combined Protection. When using really loud tools, like a chain saw, I like to wear both ear muffs and ear plugs. Noise produced by these tools can remain in the harmful range even with a protective device in place. Using both types in combination can reduce the sound an additional 10 to 15 decibels. This helps ensure the noise level will remain at or just below the harmful level.

electronic Noise Reduction

At first glance, the hearing protector shown at right looks just like a standard ear muff. But it's what's on the inside that makes a difference in how it works.

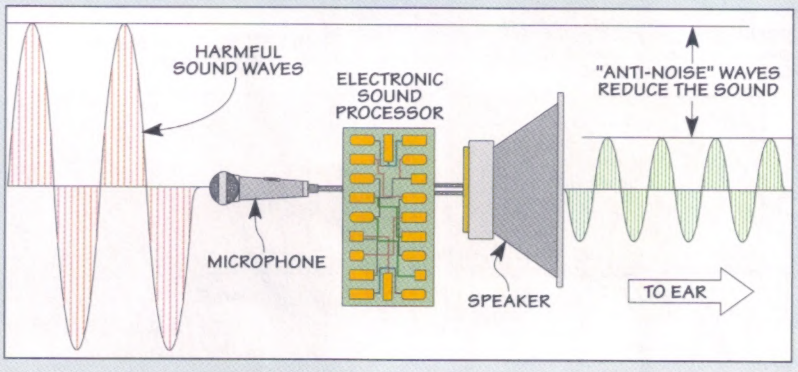
Like a standard ear muff, the *Noisebuster* reduces mid and high frequency sounds, but it also features electronic noise reduction to reduce low frequency noise (typical of engines and motors) that can really be harmful and dangerous.

To do this, a microphone inside the ear cup (drawing at right) monitors the noise coming into the ear piece. Then using electronics, a "mirror" image of the low frequency noise is created. This "anti-noise" is output into each ear cup and reduces these low frequency sounds another 20dB.

Plus, it makes it easier to understand speech and warning signals — an added safety benefit in a shop. The model shown at right also has a jack that lets you plug in a portable radio or audio player so you can listen to your favorite music at a safe level.

Technology like this isn't cheap. The *Noisebuster* runs around $150. Other manufacturers make units costing $300 and more. For more information about these and other devices, turn Sources on page 51.

▲ *Noisebuster. These ear muff protectors use electronics to reduce harmful sounds to a safe level.*

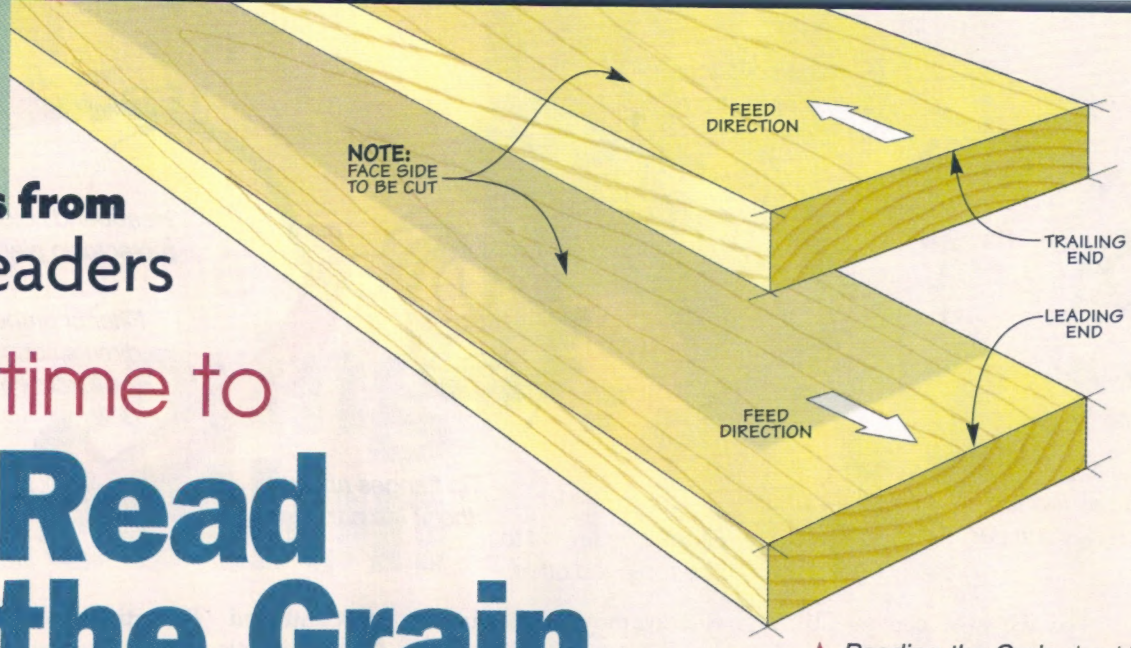


Q&A

questions from
Our Readers

take time to

Read the Grain



▲ *Reading the Grain. Looking at the grain direction on both the face and the edge of the workpiece will help determine the correct feed direction for your jointer.*

When I use my jointer to flatten a board, I often end up with a rough surface that takes a lot of time to sand out. What am I doing wrong?

Keith Wiley
Lake Nebagamon, Wisconsin

Jointers are a great tool for straightening an edge or flattening the face of a workpiece. But it's not unusual to get a cut that's rough in some areas. Instead of a nice smooth surface, the wood has patches of lifted grain or areas of chipout or tearout.

In some cases, this may be caused by dull knives or working with highly figured woods that are difficult to joint smooth no matter what you do. But most often the problem is the result of the orientation of the grain in the workpiece.

EDGE JOINTING

Determining the proper feed direction of the grain is easier when you're passing the edge through the jointer. Simply examine the face of the board and determine whether the grain slopes up or down. Then feed the piece in the direction that allows the grain to slope away from the knives. This keeps the knives cutting with the grain, as shown in the drawings below, instead of against the grain, which leads to tearout or chipout along the edge.

FACE JOINTING

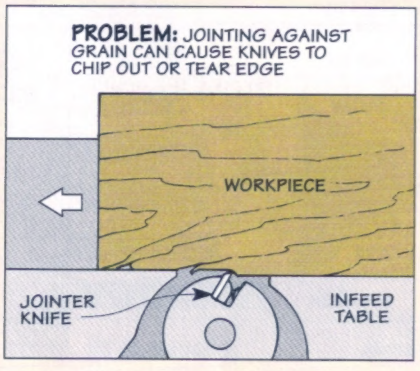
Jointing the face of a board can be a little more challenging. That's because the grain pattern may appear to be going in one direction on the face and actually run in the opposite direction, like you see in the drawing above.

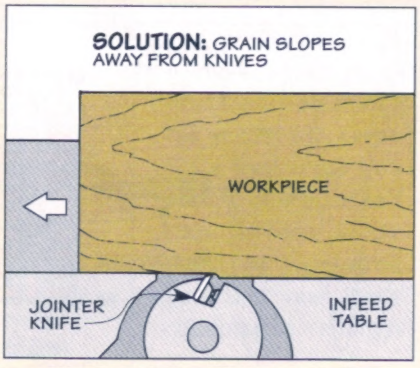
If there's a V-shaped surface grain present, it's tempting to look at the face of the workpiece and then feed the board into the jointer with the V-shaped grain pointing away from the knives. But you'll actually get a better picture of grain direction if you take a look at the edge.

In a similar manner to edge jointing, you'll want to check out the edge to see if the grain is rising or falling. But this time you'll want to feed the board into the jointer in the direction that keeps the knives cutting with the grain direction visible on the edge of the board. You'll find these same principles apply when you use your planer.

Changing Grain Direction. The grain direction may also change within a single workpiece. When you see this, you can sometimes avoid rough cuts by slowing down the feed rate when you get to the point the grain makes a change in direction. This way, the knives take smaller "bites" and you'll be less likely to end up with any chipout.

Determining grain direction is the best way to get better results with your jointer. The nice thing is it only takes you a few extra seconds, but it'll save you a lot of sanding time in the long run.





Sources

SHOULDER PLANE

A shoulder plane you build yourself, like the one on page 32, will become an heirloom and a great addition to your shop. To build the plane, you'll need some hardware and metalworking tools.

First, you'll need low-carbon steel (9517K16), brass sheet material (8956K44), and a small brass rod (8859K155). You'll also need a scribe, layout dye to mark the lines on the metal, and metal files to work the material. I was able to order all of these items from *McMaster-Carr*. The #410 *Clifton* plane iron I used came from *Highland Hardware*. The brass lamp shade extender I used for the adjustment knob was picked up at a local hardware store.

PATTERNMAKER'S VISE

A patternmaker's vise like the one featured in the article on page 12 can really add versatility to your workbench. You'll find these vises available from a number of manufacturers. The vise (168040) we used came from *Highland Hardware*.

HEARING PROTECTION

Hearing protection devices, like those on page 48, are a safety requirement in any shop. You'll find many types of ear plugs available at most home centers. The foam ear plugs (25R01.01), *Express* plugs (22R17.05), and the *Airsoft* Plugs (22R72.50) all came from *Lee Valley*.

To get the *ZEM* hearing protection unit (Z01RE0100) you'll need to order it directly from *SensGard*. You can find contact information in the right margin.

I was able to order the *Noisebuster* electronic, noise-cancelling ear muff (Model PA4000) from *Pro Tech Communications*. You can use the contact information in the margin to order these hearing protectors.

PANEL SAW

You'll be able to get almost everything needed to build the panel saw on page 16 at your local hardware store or lumberyard. But there are a few pieces of hardware you'll probably need to order to complete the project. The 48" T-track (21753), the 5/16" cam clamp (58244), the 5/16" x 1" T-bolts (33965), and the 5/16" x 1" knobs (34121) came from *Rockler*.

The toggle clamps (213-U) and the 4' (331276) and 12' (331272) self-adhesive tape measures came from the *Woodsmith Store*. Similar tapes are available from *Starrett*.

METAL JEWELING

Using the metal jeweling technique on page 30 adds a customized look to the metal parts of any project. The 3/8" x 6" medium grit cratex rod that was used to make the pattern shown on the plane in the article came from *Tool Crib*.

You can also get an "engine turning kit" (080-558-101) that includes many of the items you need. The kit I used came from *Brownells*. You'll find ordering information in the margin at right.

SHOP TOTES

The wood and hardware you need to build the shop totes on page 28 can be found at your local hardware store or home improvement center. But you'll need bins to go inside the totes to organize and store various items. The bins I used were small storage bins (Model 30210) made by *Akro-Mils*. These bins are also available from the *Woodsmith Store*.

EUROPEAN HINGES

European hinges, like those on page 10, can help solve difficult problems. You'll find many of these hinges readily available from hardware and woodworking suppliers. I found the inset and 270° wrap-around hinges at *McFeely's*. The face frame and zero protrusion hinges came from the *Woodsmith Store*. The *Silent Close* hinges came from *Wood Technology*. Clip-mount options are available for most types.

MAIL ORDER SOURCES

Woodsmith Store
800-444-7527
woodsmithstore.com
Akro-Mils Storage Bins, Hinges, Hearing Protectors, Toggle Clamps, T-track

Rockler
800-279-4441
rockler.com
Cam Clamps, Knobs, T-bolts, T-track

Lee Valley
800-871-8158
leevalley.com
Ear Plugs, Patternmaker's Vise

Akro-Mils, Inc.
800-253-2467
akro-mils.com
Storage Bins

McMaster-Carr
630-600-3600
mcmaster.com
Brass Rods, Brass Sheet Material, Sheet Steel, Metalworking Tools

SensGard
877-208-0883
sensgard.com
ZEM Hearing Protector

Pro Tech Communications
877-226-1944
protechcommunication.com
Noisebuster™ Hearing Protector

Highland Hardware
800-241-6748
highlandhardware.com
Patternmaker's Vise, Plane Irons

Wood Technology
800-231-9522
woodtechnology.com
Evolve™ Silent Close Hinges

Brownells
800-741-0015
brownells.com
Cratex Rods, Engine Turning Kit

Tool Crib
800-635-5140
toolcrib.com
Cratex Rods

McFeely's
800-443-7937
mcfeelys.com
European Hinges

Starrett
978-249-3551
starrett.com
Measuring Tapes

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Scenes from the Shop

Dovetailed Shoulder Plane. *The double dovetails of the shoulder plane shown in the inset photo highlight the brass sides and steel sole. The step-by-step instructions starting on page 32 show you how to build it with the materials you see here.*